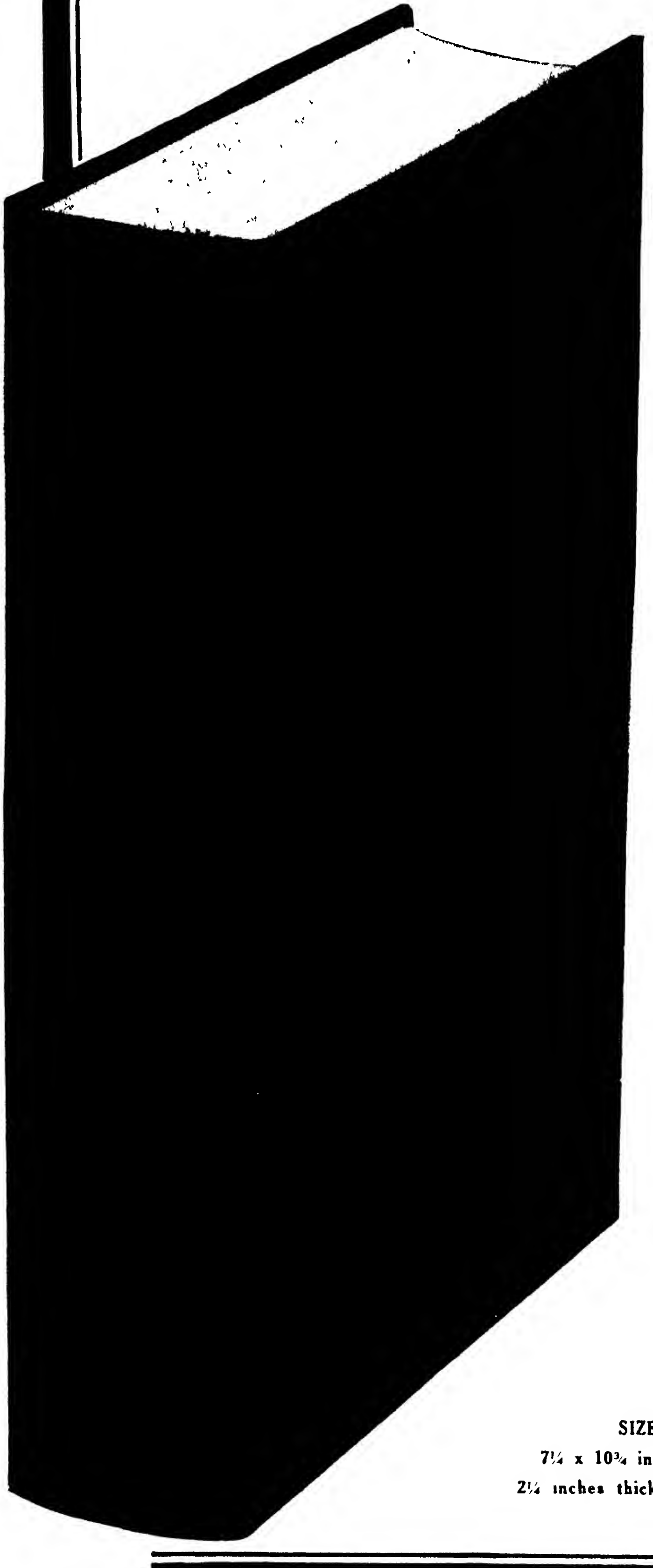
FIGHTING ENGINEERS OF THE NAVY . . . Page 54

SCIENTIFIC AMERICAN



THE linkage between industrial and military activities on far-flung fronts is photographically dramatized by Robert Yarnall Richie in our front cover illustration Here is shown a centerless grinder in one of the shops of the Minneapolis-Moline Power Implement Company, grinding the bourrelet on 155mm shells

•

SCIENTIFIC AMERICAN

Owned and published by Munn & Company, Inc., Orson D. Munn, President; I. Sheldon Tilney, Vice-President; John P. Davis, Secretary-Treasurer; all at 24 West 40th Street, New York, N Y

NINETY-NINTH YEAR — ORSON D. MUNN, Editor

JANUARY • 1943

SCIENTIFIC AMERICAN, January, 1943, Vol. 168, No. 1. Entered at the New York, New York, Post Office as second class matter June 28, 1879, under the act of March 3, 1879; additional entry at Orange, Connecticut. Published monthly by Munn & Co., Inc., 24 West 40th Street, New York City.

Files in all large libraries; articles are indexed in all leading indices.
Subscription rate $4 00 per year. Canada and foreign $5.00.

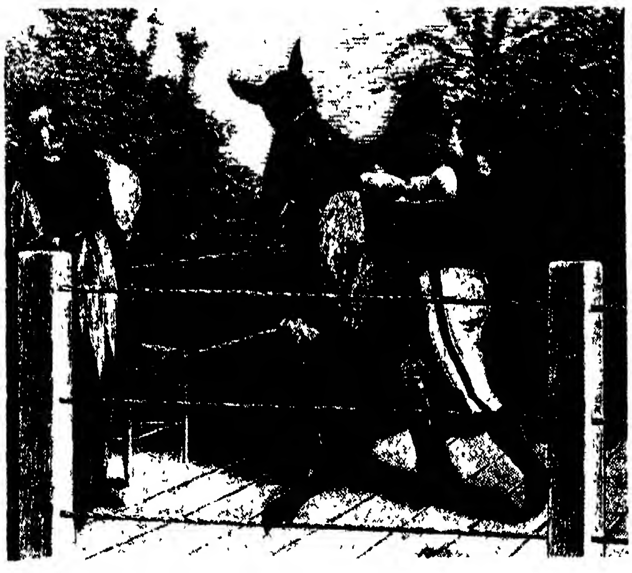
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of January, 1893)

PHOTOGRAPHY—"A proposal to erect a new monument to Daguerre in his native village of Briesur-Marne has moved M. Leon Vidal, the editor of *Le Moniteur,* to remark that but for Niepce, there would have been no Daguerre—photographically speaking, of course. Niepce was really the inventor of photography. Daguerre contributed his brick to the edifice, no doubt; but it is often forgotten that, without Niepce, photography would not have been known."

KANGAROOS—"Among the recent developments in the world of sports, in Australia, is the training of the kangaroo to stand up and spar or box with a human antagonist. . . . The way in which the natural kangaroo spars in the bush, his birthplace, is peculiar. He places his front paws gently—almost lovingly—upon the shoulders of his antagonist, and then proceeds to disembowel him with a sudden and energetic movement of one of his hind feet. From this ingenious method of practicing the noble art of



self-defense the kangaroo at the Royal Aquarium has been weaned. . . . The flesh of the kangaroo is highly esteemed as a food, and from the hides a valuable leather is made. These are legitimate uses of the animal. But it is shocking to think of degrading so useful a creature down to the level and equal of a brutal human prize fighter."

HAIL—"A great rain and hail storm took place at Gray Hill, Texas, on December 6. This remarkable hail fell in large lumps, ranging from three to six inches in diameter. . . . The average was about one hailstone to every three feet square."

MECHANIZATION—"The government of India is offering a number of prizes for the best designs or models of a cart suitable for military requirements, to wit, a mule cart for the transport use of the British army in India."

FROM AN AD—"Astronomical telescopes of superior defining power. Eyepieces, etc. Manufactured by W. & D. Mogey, New York." [Late in November, 1942, the editor attended a ceremony dedicating a new optical shop just completed by the company which has directly inherited the Mogey name and reputation. Situated in the Watchung Mountains of New Jersey, this new shop of William Mogey and Sons, Inc., is now actively engaged in producing precision optical goods for the armed forces.]

ARMOUR INSTITUTE—"Absolutely unknown to the public, work has been going on for a year past toward the erection of a magnificent five-story building on Armour Avenue, and it is now all but ready for occupancy. This building will be known as the Armour Institute, and will be to Chicago all that the Drexel Institute is to Philadelphia and the Pratt Institute to Brooklyn. This building is but a small part of the gift. In addition to it, and for its support, Mr. Armour gives $1,400,000. All that money and brains and labor can do will be done toward making it the greatest institute for manual training, science, and art in this country."

NOT YET—"There is hardly a doubt that the natural gas supply, even in the most favored districts where this agent has been discovered, is generally approaching extinction, and it will soon cease to be an important factor among the fuels of the country, particularly as far as its use in manufacturing industries is concerned."

METEORS—"The meteors of Nov. 23, 1892, as seen by W. J. Hussey, at Palo Alto, Cal., did not come at a strictly constant rate, though nearly so. On the average, a single observer could see from 50 to 60 fairly bright ones every five minutes."

AIR BRAKES—"Repeated experiments on the Western Railway of France, especially between Paris and Mantes, have shown that with the Westinghouse brake a train of average load running at 53 miles per hour is pulled up without disagreeable consequences in a distance of less than 168 yards."

ICE—"The Hudson River ice harvest is now in progress. It begins sixty miles north of New York City. The ice is ten inches thick, and is pure water ice, so clear that one can read a newspaper through the blocks. The indications are that the ice crop this year will be the largest and finest ever gathered on the river, and will reach nearly 4,000,000 tons."

YERKES—"The large disks of optical glass made by Mantois for the University of Southern California have been purchased by the University of Chicago. They are nearly 42 inches in diameter, and will allow of a clear aperture of 40 inches. The glass is said by Mr. Alvan Clark to be exceptionally good. Mr. Clark will shortly undertake the work of grinding the objectives, which he has contracted to complete within eighteen months. . . . The contract for mounting the great telescope has been awarded to Warner & Swasey, of Cleveland, Ohio."

TORPEDO BOATS—"The famous torpedo boat builder at Elbing, Schichau, has just attained an unprecedented speed even for this class of vessel, torpedo boats built by him for the Russian and Italian governments having reached 27½ knots on an hour's run at sea. The new British boats are to be 200 tons displacement, while the Russian boats are 130 tons, so that the former may do better by reason of greater power and greater size."

99TH YEAR SCIENTIFIC AMERICAN JANUARY 1943

DOWN TO THE SEA FOR SUBS

'Chasers' of World War One Come Back as YP Boats

A. D. RATHBONE, IV

NAVIGATING a busy harbor at 0415—quarter past four in the morning in civilian life—in the necessary dimout of wartime is one of those situations where you do your best—and keep your fingers crossed all the time. Keen eyes peer anxiously from bow and flying bridge through the murky pre-dawn haze; the skipper stands tensely beside the helmsman in the darkened wheel-house, and though we're full of questions up to the ears, we hold our tongue, for even a landlubber can sense the strain of the moment as our ship, the *YP 191*, slides gingerly through the narrows on a trip with the Inshore Patrol

Another craft, long, sleek, racy, comes slowly toward us from starboard. Our engine-room bell clangs, weirdly in this half-light The Coast Guard cutter and our ship slowly nose toward each other, and we receive our sailing orders

There is a devastating roar overhead and a couple of Navy patrol planes flash past and on out to sea They're looking for submarines So is the Navy blimp, stodgy by comparison, that abruptly shears the clouds of morning mist to hover protectingly over the squat hulks of freighters which have mysteriously emerged from the fogs of dawn As more snarling planes appear and almost immediately vanish in the still gray sky, our convoy takes shape and moves pokily off down the coast The laden steamers line up one-by-one, with Coast Guard cutters and our ships flanking, a British trawler and a corvette respectively closing the guardian floating box fore and aft, and we're off

Soon after the Japs landed their sneak-punch in our Hawaiian solar plexus, the Nazis started hitting our merchant marine below the water line in coastal lanes as well as on the high seas—and momentarily there was little

● So effective has been the work of the YP boats in stemming the depredations of Axis submarines on the Atlantic and Gulf Coasts that one of the editors of Scientific American delved deeply into the how and why of the Inshore Patrol. In the accompanying article he takes the reader mentally on a patrol trip, shows him the inner workings of this effective branch of our Navy. Photographs not otherwise credited are exclusive to Scientific American, and have been approved by the Navy Department.—*The Editor* ●

we could do about it. We had neither ships nor men to man them. All of our destroyers, generally conceded to be the submarine's deadliest enemies, were needed everywhere at once All hell was loose in the Pacific, and as attacks on Atlantic and Gulf coasts by a Nazi battle fleet weren't considered likely or even possible battleships, cruisers, destroyers, and other major warships were elsewhere

THE NAZI submersibles promptly took advantage of the situation and began sinking freighters right and left, many within sight of the coastline To establish an Inshore Patrol which would put the quietus on this audacious practice would require boats, more boats, and still more boats—and thousands of trained men to man them True, the Coast Guard and such naval units as were available were instantly on the job, but despite heroic efforts through last year's freezing, blustery, wintry weather and notwithstanding long hours on watch day and night, there simply were not enough ships adequately to patrol the 1888 miles of Atlantic coast, the 1686 miles of the Gulf coast, to say nothing of the sea frontiers of California, Oregon, Washington

The man-power problem showed immediate signs of self-solution. Potential sailors and officers poured into recruiting stations faster than they could be cared for. Long-range plans had foreseen such an emergency and the prepared programs for training seamen and junior officers went into effect with few hitches and little static Specialty courses for signalmen, motor machinists, firemen, and men to master the intricacies of sound-detecting devices sprang up all over the nation The man-power problem was on its way to be licked, but the ships for this new Navy—where were they?

As early as a year ago miracles were being wrought in American shipbuilding yards, but not even miracles could produce with sufficient rapidity enough small, speedy craft capable of guarding all our coastal shipping lanes. The need for ships was imperative—now—had been so for weeks—and tomorrow or next month just would not do. Although the War Shipping Administration had had under way for some time plans to build a fleet of 110- and 173-footers, the lack of steel, Diesel engines, fittings, gear, and armament had retarded production As in 1917 when faced with a similar problem on a smaller scale, Navy scouts who knew good ships when they saw them explored coastal harbors, peered into yacht basins, and poked their noses around every mooring where it was conceivable that usable, sea-worthy boats might be found

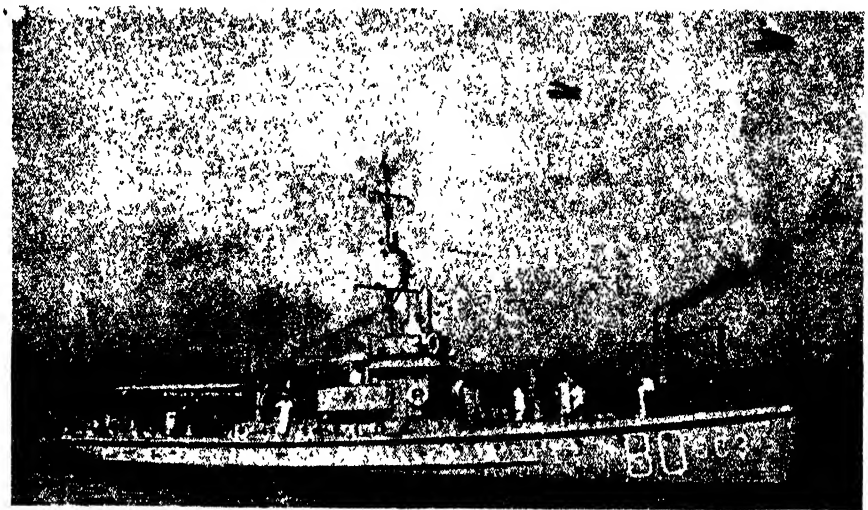
FROM this naval dragnet came as conglomerate a collection of craft as those that braved Dunkerque's dangers—and with them, whether or not the Navy liked it, as dare-devil a crew of amateur skippers as ever tasted brine who insisted on accompanying their ships into naval service. In some quarters criticism and contention followed the Navy's "Awfully sorry, but we just can't use your ship." Disgruntled owners, however, failed to realize that when a boat is too small to satisfac

mount even a 50-caliber machine when she hasn't the speed to es- ; from an exploding "ash-can" .umped from her own stern, when he isn't built to survive the riotous Atlantic storms, when there aren't enough two-way, or even one-way radios to go around, it is the utmost folly to enlist her services

Our own ship in this convoy is one type of craft which the eagle-eyed naval scouts did locate and one they had hoped with a faint hope, indeed, to find—the wooden-bottomed submarine chaser constructed for service World War 1. Nearly all of these d been sold into private service ter the Armistice. Formerly known s S. C. Boats, their full load displacement was 76 tons, they were 110 feet in over-all length, 15 feet, 4¾ inches extreme beam over guards, and had a draught of five feet, 11 inches Their planking was of 1¾-inch yellow pine, with white oak steambent frames 2½ by 3 inches, spaced at 12-inch centers Deck planking was Oregon pine, and they were originally equipped with six watertight bulkheads

When built 25 years ago, the S C.'s were powered with three main six-cylinder, four-cycle gasoline engines rated at 220 horsepower, at 400 revolutions per minute. Generally, the wing motors were utilized in cruising, the center motor being disconnected from the propeller shaft through a heavy clutch. Speed of these diminutive World War ships varied according to conditions, and although some of them were reported to have attained speeds of 17 to 19 knots, the experience of the fleet as a whole showed an average top speed of 14 knots.

These were the ships of "The



U S Navy Official Photo

Today's veteran "Splinter Ships," save for lack of portholes and crow's nest, resemble this sub-chaser of last war in nearly every respect. Note old style flying boats

After-deck of YP 191, with machine gun and "ash-cans" poised at stern

Splinter Fleet," that brave little American Armada which, with only a 2400-gallon gasoline storage capacity per ship and a daily consumption of 600 gallons, with an armament as pitiful as toy pistols compared to that of the enemy, were expected to—and did—convoy ships across the Atlantic. Furthermore, they were expected to—and did—chase and sink submarines Eleven of those midgets engaged in maintaining what was known as the Otranto Barrage—a bottling-up of enemy ships in the Adriatic Sea—and in the bombardment of Durazzo, Albania, in October, 1918.

So far as being in trim as fighting ships, the condition of the few old S. C.'s which were re-discovered was pitiful, but far from hopeless After major Navy Yard operations which provided new decking, replaced worn struts and braces, slapped on coats of war paint, and made a hasty overhaul job on the Diesel engines—which weren't new, but which had replaced most of the original gasoline-powered motors—the 25-year old sub-chasers were once more rarin' to go after their old enemies And that same scrappy spirit that must have originally been innoculated into the very timbers of the veteran S. C.'s seemed to imbue the young freshly trained sailors of our new Navy, for early in 1942 those rejuvenated ships and their crews put to sea with no more armament than a box of 25-pound chunks of dynamite equipped with 11-second fuses These crude but lethal weapons, which were temporary substitutes for depth bombs, plus a Tommy-gun for good measure, were the sum total of the old Splinter Boats' fire power when they first went out to help the Coast Guard and the few available Navy ships beat off the Axis submarine menace to coastal shipping. Today they're known as "YP" Boats—ours is *YP 191*—and they keep constant and co-operative company with the Coast Guard cutters, the mine sweepers, the converted private yachts, and the score or more of British armed trawlers and corvettes that have come over to help patrol our Atlantic and other coastal shipping lanes

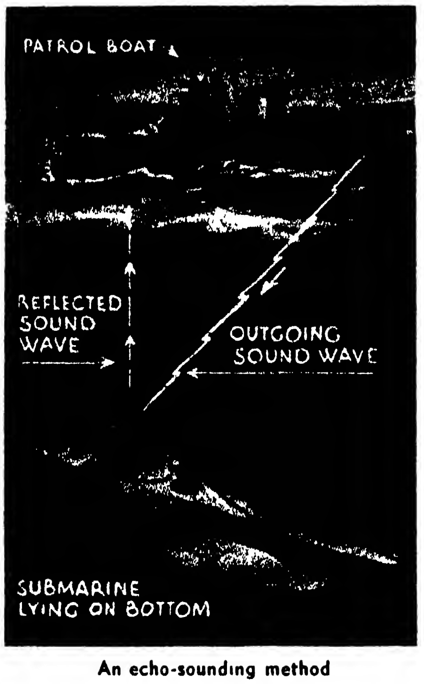
Ensign McCallum, skipper of the *YP 191*, introduces his two fellow officers, likewise Ensigns who have come into their epaulets since Pearl Harbor. Then we meet the crew, as true a cross-section of America as ever manned a Splinter Boat—or any other ship There's a Mulligan, a Burke, and a Degnan, a Luzietti, a Kabat, a Morris; a Hanson, a Crosby, a Bartlet, and others, 17 sailors in all, to make up the crew of this Lilliputian sea fighter While the officers wear their regular uniforms and maintain a certain amount of dignity, the deck crew, the black gang from the engine room, and "Cookie" all wear dungarees, and when weather permits, most of them are naked from the waist up. In the days to come we'll find that while discipline is ever-present, it is of a distinctly informal brand which perfectly fits the cramped conditions on a small ship, obtains the maximum amount of co-operation from the men, and produces a loyalty and admiration on the part of the crew for the officers that would exceed the demands of the strictest four-striper.

Sitting on the steps of the wheel house, enjoying the sun's warmth after the early morning chill, our ears are suddenly stricken with an outlandish garble of words: "Negat . . . Afirm . . . George . Fox . . . Negat . . Afirm . . George . Fox — Come in, Negat

. Afirm . . . George . . . Fox . . ." And before we have time to realize that this is the voice of the two-way radio functioning, we hear the reply from "Negat . . . Afirm . . . George . . . Fox . . ." answering and standing by.

At frequent intervals throughout the rest of the day and through the night the radio, constantly in tune with shore headquarters for this area, gabbles away in this seemingly garbled language. Thus does the shore control constantly keep in contact with every ship, plane, and blimp engaged in the duty of Inshore Patrol.

Another device whose acquaintance we soon make is the listening apparatus tucked away below decks in a tiny cubicle called the "sound room." Back in that other war this boat, her sister ships, and many other craft were equipped with hydrophones which, when the ship was stopped dead still, enabled listeners to hear the sound of submerged U-boats' propellers. The hydrophone consisted of two rubber "ears" mounted on the ends of an inverted T pipe which could be lowered into the water under a chaser's hull. The "ears" were hollow rubber balls, with a copper tube inserted in each. These tubes, protected by a bronze pipe, extended up inside the ship, terminating at the listening post, and were connected to the ear pieces of an physician's stethoscope. The vibration from any sound made by a submarine or other ship could be heard through the stethoscope, and by turning the submerged T-shaped arm until the sound was equalized in the ears of the listener, the direction was determined. Applying the triangulation method of civil engineers to their hydrophones in order to spot a hostile object, a unit of three splinter ships could arrive at a close approximation of the location of the U-boat—and then proceed to drop depth bombs in the suspected area.



An echo-sounding method

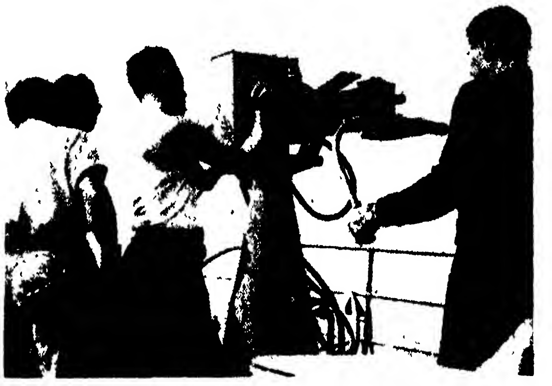
The basic principle of locating submarines has not materially changed since the last war, but science and inventive ingenuity have streamlined the process and refined the apparatus. Formerly, if an enemy submarine lay quietly on the bottom of the sea to avoid detection, and if its commander was sufficiently unobliging to refuse to revolve the ship's propeller now and then, the business of "putting the finger" on a sub became more difficult and less accurate in its results. In the present conflict, the principle of sound reflection under water, long applied to larger merchant and war ships to maintain a continuous graphical record of the ocean's floor beneath the cruising ship, is being adapted to search out silent submersibles that endeavor to "play possum" far beneath the waves.

The exact extent to which echo sounding devices are utilized and their scientific and mechanical constituency are among those things which cannot now be told.

A "dungaree sailor" cleans a gun

In addition to ears, the convoy guardians have eyes. Ever overhead, the blimp hovers and circles; planes, Army, Navy, and Civil Air Patrol, come and go in an unceasing search for Axis subs which may be lying in wait for hapless victims.

Interrupting the more scientific side of our investigation comes a lusty call from the galley: "Chow down!" and we hasten up the companionway ladder and aft toward the tempting smells eminating from a full course chicken dinner. Yes, the Navy eats sumptuously and well, with plenty of wholesome, nourishing food expertly prepared. We marvel at "cookie's" dexterity in his tiny galley, which from the rolling and heaving of the ship and the healthy appetites of an ever-hungry crew, never knows a still moment at sea. Eventually we acquire the knack of keeping bowls of soup, mugs of coffee, and platters of food from dive-bombing into our lap. "Cookie" tells us that, "When I open the ice chest doors on a rough day, it's as though 30 people were standing over there throwing things at me!"



Machine-gun drill aboard YP 191

After chow the "Dungaree Navy," those youngsters from Texas and Iowa, from Massachusetts and Michigan, from all walks of life, go about their duties and we are again and again amazed at their knowledge of seafaring ways and the efficiency they have acquired in so short a time. We can't help but wonder what the Japs were thinking of when they picked on us.

Only 12 months past it was touch-and-go in the Atlantic coastal battle with the submarines, as well as elsewhere on the Seven Seas. But today, under the guidance of Vice-Admiral Adolphus Andrews, United States Navy, Commander of the Eastern Sea Frontier, the safe convoying of ships up and down our coast from Florida to Nova Scotia is an accomplished fact. With ships and men ever more available, the little ships of this war are now expanding their protective services to include the Carribbean Sea, the Gulf of Mexico, and our Pacific frontier to an even greater extent than has heretofore been possible. To man this new Navy comes a never-ending stream of a new generation of "iron men in wooden ships," true American sons of the men who commanded the *Bon Homme Richard* and the *Constitution*.

Spreading The Tin Thin

Rapid Recent Development of Tin-Plating Processes and Reflowing Methods Is Resulting In Better Tinplate

A. P. PECK

When supplies of tin from the Far East were pouring freely into the United States, there was no trouble at all in obtaining the 70-odd thousand long tons of the shiny metal that were consumed annually in this country. A large part of this tonnage went into the production of tin plate for fabrication into containers of all sorts, the remainder into various other articles of commerce But when the Japs moved into the Malay Peninsula, the Dutch East Indies, Thailand, Indo-China, and Burma, they cut off two-thirds of the world's supply of tin, and set up a production problem for research engineers of the United Nations that is already being solved on a large scale

The time-honored method of applying tin to a sheet-iron surface in the manufacture of tinplate is, briefly, to dip the cleaned and prepared iron sheets into molten tin. A relatively thin film of the soft metal (some 90 millionths of an inch thick) adheres to the iron surface and protects it against corrosion, attacks by certain acids and some other active chemicals, and makes an ideal combination for the well-known uses to which tinplate is put.

In this hot-dip process, 1½ pounds of tin are normally applied to the surfaces of 100 pounds of sheet iron. This figure, incidentally, has been reduced to 1¼ pounds by government decree, as part of the whole program of tin conservation.

Several years ago, long before it became obvious that much of the world's tin was going to fall into the hands of international bandits, metallurgists and others were experimenting with a variety of methods of applying a tin coating to sheet iron It is unnecessary, these research men reasoned, to produce, for some purposes, such a heavy tin coat as is provided by the hot-dip method Thus there was developed an electroplating process of depositing tin on iron, making it possible to produce tinplate that required only about one third of the amount of tin consumed in the more conventional hot-dip process

Tin reflowing by means of induction heating was demonstated and explained by Mr. Baker, shown here with laboratory set-up

True, this plating method, generally referred to as the electrolytic process, used less tin because it produced a thinner coating This plate, however, was considered satisfactory for many purposes, although it was early found to have some drawbacks

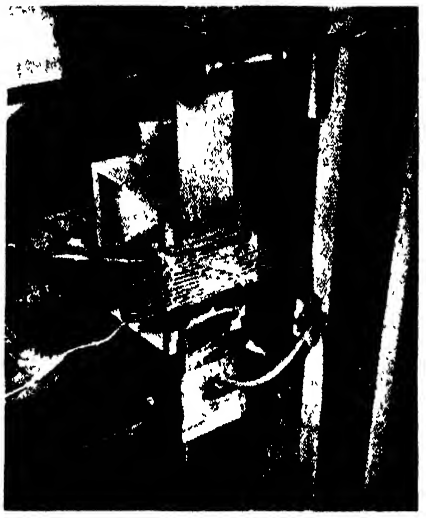
In the first place, electrolytic plate emerged from the tanks with a gray, unpolished appearance that was by no means as pleasing to the eye as is the mirror-like surface of hot-dip plate Further investigation revealed that this dull appearance was due to irregularities in the thickness of the plating. Since the electrolytically deposited tin coating has an average thickness of only 30 millionths of an inch, these irregularities resulted in unsatisfactory protection of the base metal Furthermore, these same "hills and dales" in the tin surface interfered with later fabricating processes, causing stacked sheets to stick together and preventing consistent operation of suction-cup lifting and handling mechanisms

The solution to the problems thus posed seems simple at first glance, yet becomes complicated when production factors are considered. All that has to be done is to heat the tin coating to its melting point—some 450 degrees, Fahrenheit — whereupon the molten tin will spread over the base metal in a uniform coating that will solidify to a smooth, shiny surface when cooled. That's all there is to it, but how can the tin be melted—reflowed is the term generally applied to the process—and then cooled at the speeds required for today's electrolytic tinplate production?

Several methods have been developed for this reflowing operation The most important involve the use of hot oil baths, passing the tin strip through a radiant tube or other type of furnace, using the electrical resistance of the strip itself to heat it when a current is conducted through the strip, or passing the strip through a high-frequency induction heating coil In some cases, a combination of two of these methods may be found desirable

The hot-oil bath for reflowing tinplate can be used successfully only on low-speed production lines Because the differential between the melting point of tin and the temperature to which the oil can safely be heated is very low, the speed is limited. Also, since the oil heat reservoir can be maintained only at a relatively low rate of restoration, and the temperature cannot be quickly altered, the strip must be passed through the bath at a constant speed, a factor which is undesirable when the operation of tinplate production lines is considered.

The furnace method, regardless of the type of energy used, also is satisfactory for low-speed, constant-speed work, but becomes quite bulky as the speed of the strip is increased The furnace must be from about one third to one half foot long for each foot per



Close-up of the induction heating coil and water quenching tank in the tin reflowing unit shown on page 7

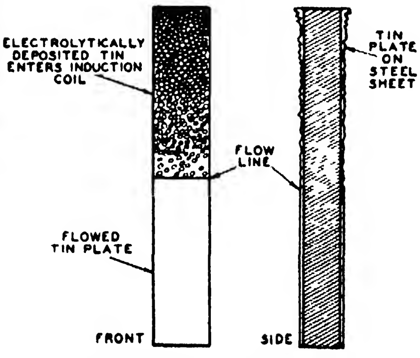
minute that the strip travels, thus setting a reflowing speed limit of 200 to 300 feet per minute for the radiant furnace. Here, again, since the heat can neither be generated nor dissipated at a high rate, the use of this method is restricted to constant-speed operation.

Because of the limitations of hot-oil and furnace methods of tin reflowing, they cannot readily be incorporated in the electrolytic-tinning line itself. They must be used as a separate set-up, making necessary an additional operation and extra handling of the strip during processing

Melting the tin by the heating effect of current flowing through the tinplate itself does not have the speed limitations of hot-oil or furnace methods. Also, since the current can be readily controlled, this method is adaptable to production lines in which the speed is not always constant. The amount of heat generated can be readily adapted to the speed of the line.

With the conduction heating method, however, there is the problem of getting the electrical power into the strip at high speeds without arcing and burning at the contact rolls. Because the molten coating is in actual contact with the current-collecting rolls, there is a possibility of marring the tin surface Thus, it becomes necessary to heat a section of the strip while at the same time attempting to quench it.

By the induction heating method it is possible to reflow tinplate strip at high speeds and under conditions of continuous operation. In this process the tinned surface is brought to the melting point by the same methods now extensively employed by industry in other types of electromagnetic heating, except that the frequency is much higher and the power involved is much greater In the induction heating system there is no physical contact between the strip and any stationary or rotating part. Therefore, there can be no marking of the strip either by electrical or mechanical action. The heating is done in a very short space even at high speeds, the space required on the processing line being on the order of 10 to 12 feet for a strip speed of 1000 feet per minute



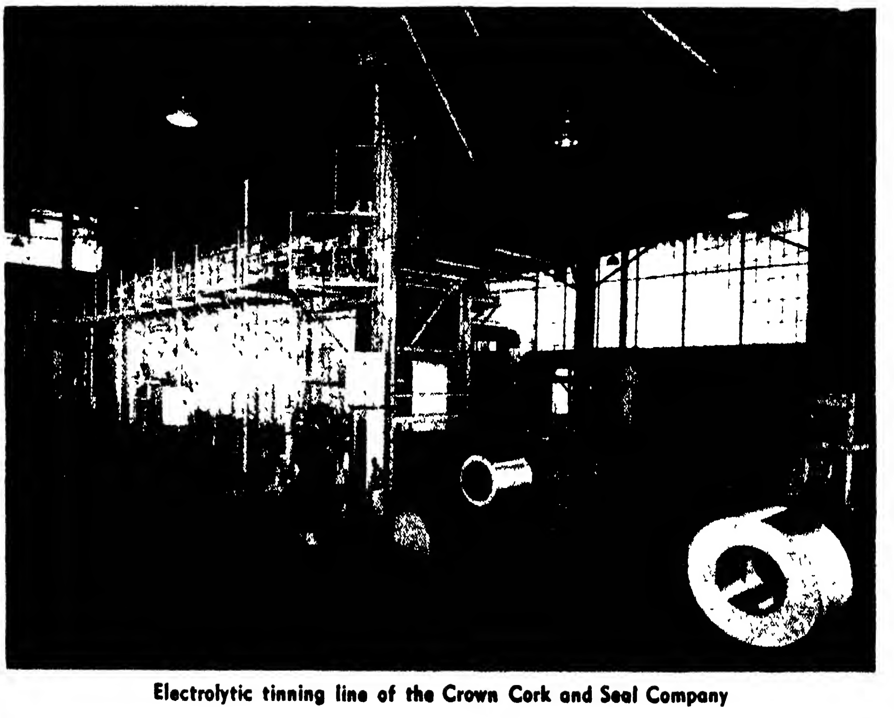
Matte surfaced tinplate strip becomes shiny and smooth when reflowed. Flow line indicates point where induction heat makes the transformation

Since the reflowing process as applied to tinplate is a relatively new operation, practical experience may indicate the desirability of using some combination of the methods just briefly described In such a combination the tinplate might be preheated by, for example, the conduction method, while the final heating to the reflowing temperature would be accomplished by the induction process.

Most significant feature of the induction heating method of tin reflowing, which was recently brought out of the laboratory and into industry by engineers of the Westinghouse Electric and Manufacturing Company, is its adaptability to the electrolytic tinplate production process. Not only can it reflow tin at speeds as high as the fastest electrolytic line can produce the plate, but it can be designed as an integral part of the line itself. Thus it becomes possible to maintain continous production of electrolytic tinplate, in rolls or sheets, with a surface that is entirely satisfactory for many everyday purposes. Then, too, automatic control of the operation becomes possible, since the heat produced can be instantly and automatically adjusted to correspond to any change in speed of the strip merely by controlling the power input to the inductor coil. By such adjustments the correct temperature to melt the tin is maintained and oxidizing of the strip is eliminated

Two of the accompanying photographs show details of an experimental model of a tin reflowing induction heater. The simplicity of the system—aside from the relatively high power required—is readily apparent. A strip of electrolytic tinplate passes through a flat coil of heavy wire, the ends of which are connected to an oscillator of suitable power. Just below this coil is a water tank through which the metal strip passes for quenching

In demonstrating the induction heating method, Mr. R. W. Baker, Westinghouse research engineer, used this experimental model in which the tin strip to be reflowed is wound on a reel at the top of the framework. When



Electrolytic tinning line of the Crown Cork and Seal Company

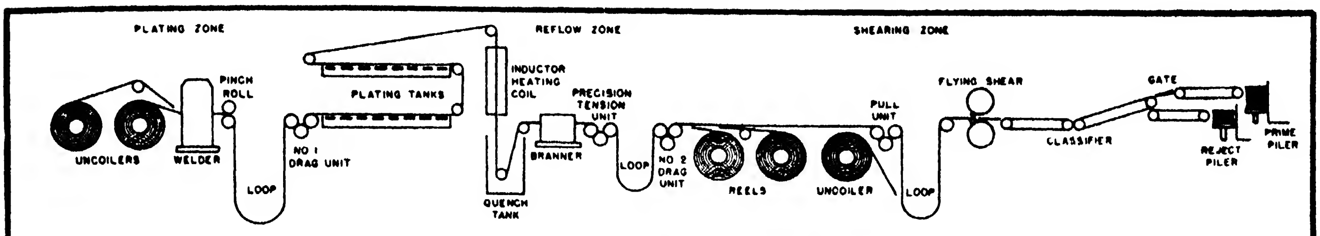


FIG 10

Simplified drawing of a horizontal-tank tinning line, with reflowing unit in its proper place

the machine is in operation, the strip, dull and with a matte surface, passes through the coil, through the water tank with an accompanying hiss of steam, and emerges from the tank displaying a bright, shiny surface

Here is how Mr Baker explains what happened in the inductor coil

"As the dull strip moved through the coil, radio waves whipped round and round the metal, setting up counter currents near the surface and melting the minute peaks down into the tiny valleys.

"Shooting into the tin, the waves ripped electrons — so tiny you could put ten million, million on an inch-long line—from the atoms of tin These electrons, driven along by the current, smashed into one atom after another, creating heat at each collision. Multiply that process millions of times and the coating of tin flows smoothly. The melting action stops when the strip moves out of the coil and the water tank cools the metal"

THE CURRENT energizing the coil of the induction heater in the experimental model is at a frequency of 200 kilocycles, supplied by equipment roughly equivalent to that of a broadcasting station, less the many refinements needed for communication purposes. This frequency is not highly critical, and depends upon the thickness of the sheet For the usual run of tinplate, of the order of 008 to 011 of an inch thick, 200 kilocycles has been found most practical, and is capable of handling, without change, the thickness variations found in commercial strip The power required depends, of course, on several factors, including width of strip to be reflowed and the speed at which the strip must pass through the heating coil On some of the large projected lines 1200 kilowatts will be needed, based on a strip speed of 1000 feet per minute

To complete the picture of this newest development in a vital industry it is needful to glance briefly at the electrolytic tinplate process itself, and to see just how the tin reflowing system fits into it Another of our photographs shows a modern electrolytic tinplate production line; one of the drawings shows in highly simplified form a similar line with the tin reflowing equipment as a built-in part of the whole.

THERE are several types of tinning lines so far developed, having two basic differences. One is whether the speed through the plating bath is held constant or allowed to decrease when a fresh coil of steel strip is to be entered into the line The other principal difference is whether the plating tanks are vertical or horizontal In one type of mill the strip moves through the plating tanks at constant speed, and means are provided for accumulating enough slack at the entry end to allow a new strip to be welded on In the other scheme, which in general allows an overall faster strip speed, the entire line is slowed down when it is necessary to start a new roll In the system which employs horizontal plating tanks, the two sides of the sheet are tinned separately, allowing variation in thickness between the sides and even in the kind of metal deposited In the vertical tank method the sheet is tinned on both sides as one operation and hence both sides are exactly alike

The type of line shown in the accompanying drawing is a high-speed set up with horizontal plating tanks, designed for operation at 650 feet per minute, but with a possible top speed as high as 1300 feet per minute. However, it is impractical to shear tinplate strip into sheets at speeds faster than about 700 feet per minute, since there will be excessive buckling of the sheets above this speed, and provision has been made in the line for coiling the finished strip and then shearing it into sheets as a separate operation when the line is run at high speeds

From the plating tank the strip passes through the reflowing unit and into the quenching tank Then oil is applied to the surface and the excess oil is removed in the branning machine From this point on the strip passes through the necessary drag and pull units into the shearing machine, or onto a reel

Although some provision is made for accumulating slack in the strip, to be used up while a new reel is being welded in place at the entry end, it is possible to accumulate only enough slack for about four or five seconds of operation. Because the welding operation requires about 30 seconds, the line must be slowed down in order to weld new coil For this slowing down process it is entirely possible to regulate the functions of all parts of the line, including the plating action and the induction heater, so that the finished tinplate remains uniform, regardless of variations in line speed

WHILE the equipment needed for the induction heating method of tin reflowing is somewhat more expensive than ovens or hot-oil baths, the speed and flexibility of the process are sufficiently desirable ends to warrant the increased cost Then, too, the development and application of this process may prove to be the opening wedge which will stimulate research along similar electronic lines in the steel industry Once the ball of research starts rolling along a newly opened alley, there is no telling in advance how many pins will be knocked down

• • •

VINYL ACETAL

Being Used To Replace Rubber In Fabrics

THE thin layer of tough, resilient plastic which ordinarily would have gone into the safety glass windows and windshields of the new car you might have bought this year will be used instead to replace rubber in Army raincoats, and in a score of other vital war items now made from rubberized fabric. The plastic is Monsanto Chemical Company's Saflex, one of the group of synthetic resins known technically as vinyl acetals.

The process for compounding Saflex so that it can equal and even surpass the performance of natural rubber in water-proof fabrics was developed by Joseph L. Haas, technical director and fabric superintendent of the Hodgman Rubber Company, oldest rubber firm in the country.

Saflex-coated fabric, which the Hodgman company has christened

Horco-X, has already been used for Army raincoats, hospital sheeting, gas protective fabric, life-preserver jackets, and water bags, while many other military items are awaiting final action or still are in the experimental manufacturing stage

In Army raincoats, the process for using Saflex will save more than 1¾ pounds of crude rubber per coat while proportionately greater savings will result from its use in heavier fabrics such as the hospital sheeting and gas protective cloth. With a 10,000,000 man Army, the saving in raincoats alone would amount to as much as 17,500,000 pounds of rubber. At the same time, since it is possible to use a lighter base fabric with Saflex, the new Army raincoats will weigh two pounds less than the present rubberized coats, making Johnny Doughboy's pack that much easier to carry.

Another advantage of the plastic after it has been compounded according to the Hodgman formula is that it can be applied to fabric with the same equipment and processes as rubber.

HARDENING

By Induction Process

Speeds Production

The process of induction heating, cutting down production time in many war industries, has, as an outstanding example of its usefulness, doubled the speed in which 28-inch sprockets of heavy-duty tractors may be hardened.

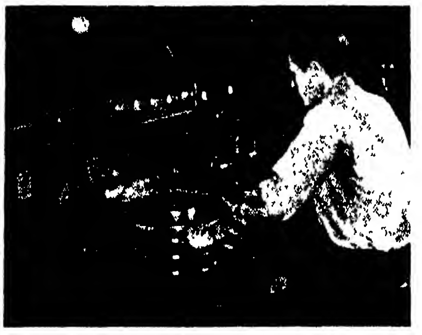
A Tocco machine for hardening the heavy sprockets is being used by the Cleveland Tractor Company and was designed and installed by the Ohio Crankshaft Company, where the process was developed. The sprockets are used to drive the tracks of high-speed tractors which have gone into heavy military duty at airports.

Previously only six to eight sprockets could be hardened in an hour, but now approximately 15 of these tractor parts may be hardened in the same length of time by the specialized process, which is not only a more rapid method of heat treating than any previously used, but more precise, according to W. A. Silliman, chief metallurgist of the Cleveland Tractor Company.

The tractor company's problem was to harden the engaging surfaces of the teeth to withstand the wear imposed by the contact with the driving lugs on the tracks. While the surfaces of the teeth are hardened, the rest of the sprocket must be kept ductile.

Mr. Silliman pointed out that one important advantage of the Tocco process is the accuracy of control over the depth of the heat treatment and over the area of the hardened zone. The accuracy is made possible by the very nature of induction heating.

The operator places three sprockets into the hardening machine at one



Quenching the induction-heated teeth on three high-speed tractor sprockets

time. The induction block of the machine contains three inductors, each surrounding a sprocket area under treatment. High-frequency current flowing through the inductors sets up a current in the sprockets, heating the metal to 1500 degrees, Fahrenheit.

The heat is maintained for 10 seconds, and the current automatically shut off. A stream of water then is turned onto the metal, which is quenched for 10 seconds. As one cycle of heating and quenching is completed, the operator pulls the sprockets from the inductor block, sets the index on the fixture and moves them forward to begin another cycle

STEELS FOR STEAM

Boiler Plants Use Chromium

Steel Tubing and Castings

Wrought and cast steel parts used in boilers differ in alloy composition in accordance with the requirements of the service for which they are intended In general, the chromium content of the steels is determined by operating temperatures, although the strength requirements of the installation must also be taken into account.

In many industrial steam-generating units, for example, the tubing used for convection-type superheating elements operating in lower temperature ranges is made of molybdenum-bearing steel, containing 1.5 to 2 percent of chromium. Here good strength is desirable, but scaling and corrosion are not severe enough to necessitate the use of steel of higher chromium content. However, when higher steam temperatures are required, which may be obtained by the use of radiant-type superheaters—the coils of which are exposed directly to furnace heat—steels with good resistance to scaling and corrosion and also good creep strength must be employed. Either 4 to 6 percent chromium steels containing molybdenum and columbium or titanium, or an 18-8 type of chromium-nickel stainless steel have been found satisfactory. This latter type of stainless steel is also used for furnace damper blades, and support beams for boiler economizers—*Electromet Review.*

CONSERVATION

Of Scarce Materials in

Design of Ordnance Equipment

The greatest program of design and redesign in history, concentrated on the firing weapons and equipment used by our soldiers, is now in full progress, according to an article in *Product Engineering.* The article, by Lt Col. J. H Frye, of the Ordnance Department, United States Army, states that the program is aimed at the conservation of every ounce of strategic material possible.

Already, it is pointed out, the substitutions and other engineering changes made by the Army Ordnance Department will result in the following known savings in major strategic materials through 1943:

Primary aluminum ..	170,000,000 lb.
Nickel	49,000,000 lb
Chromium	9,700,000 lb
Vanadium	1,250,000 lb.
Tungsten	17,500,000 lb.
Copper	671,000,000 lb
Tin	12,000,000 lb
Rubber (crude) ...	60,000,000 lb

Furthermore, says Col Frye, the design changes and materials substitutions have been made without affecting safety or military efficiency of the war material Under no circumstances are chances taken with safety or quality. "Ordnance engineers," he points out, "are often criticized for their conservatism, for insisting upon thorough testing and proving, but the men on the firing line are glad that this is so."

Important examples of materials conservation, given by Col. Frye, include substitution of steel for brass in cartridge cases, steel for aluminum on 90mm anti-aircraft gun platforms, and the redesign of tank tracks to eliminate the use of rubber by employing other materials.

One of the most interesting substitutions effected—that of steel for brass in cartridge cases—was the result of a

co-operative effort in which American industry and Army Ordnance participated. It involved an intensive research program in which design played a most important part. "The successful termination of this research project," says Col Frye, "is a signal tribute to American engineers, both Army and civilian, for many other countries had been trying unsuccessfully to make artillery cartridge cases of steel for years

"True, the Germans and others had them in World War I and are using them today, but the latest advices are that ramming may have to be resorted to in order to extract the empty case from the gun after it has been fired," he declares. "This cuts materially the rate of fire, and artillery using European steel cartridge cases cannot be employed in barrage or other rapid fire.

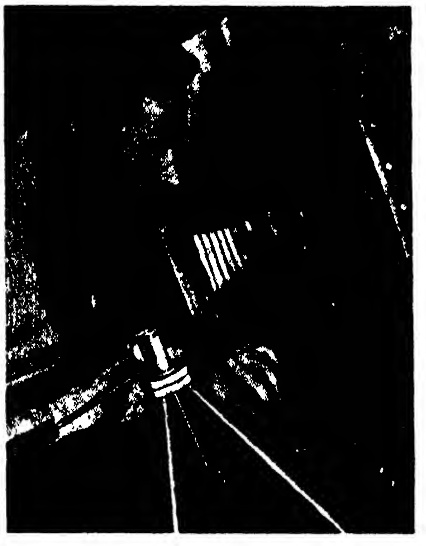
"The steel cartridge cases developed in the United States are quite as satisfactory as the brass ones, and production orders have already been placed with more than 45 manufacturers "

How the various problems of design, metallurgy, and processing were solved is a military secret but it is sufficient to point out that practically all sizes of artillery cases now are being made from steel, and it is estimated that the saving in copper in 1942 will be 100,000,000 pounds, and in 1943, 591,000,000 pounds.

Another interesting design problem was that of the 90mm anti-aircraft gun platform The original design, it is stated, specified aluminum floor plates because the added weight of steel plates of conventional design required five minutes longer for the gun to go into action In the event of an air attack, a difference of five minutes would likely mean the difference of having or not having the battery and its crew after the attack Some difficulty was experienced in tool and design, but as a result of co-operative efforts between industrial and Ordnance Engineers, a highly satisfactory steel platform is now being produced It even saves a few seconds from the best previous time required for a gun to go from battery into action.

The redesign of tank tracks to eliminate the use of rubber has presented some difficulties, particularly because the urgency required fast action. The old design would have used many thousands of tons of rubber for this purpose alone, and represented one of the major Ordnance rubber requirements. These tracks are an ideal steel casting or forging job, and the problem would be simple except for the limited available capacities of these industries and of machine tools for finishing. As a result of these conditions, it has been necessary to design for several different methods of manufacture.

In addition to the use of castings,



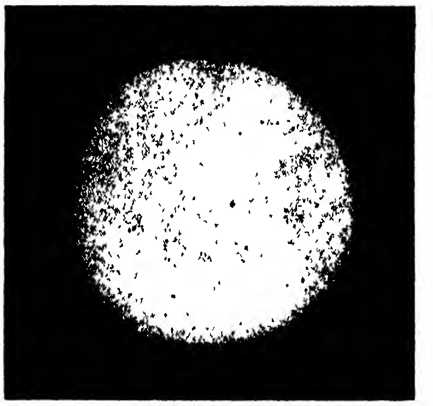
shoes have been developed by utilizing combinations of castings, stampings, and rolled steel sections Here again, military regulations do not permit a description of these constructions, but the important point is that satisfactory tank tracks are being produced which eliminate more than 85 percent of the former rubber requirements

SPRAY ANALYZER

May Help to Cut Gasoline Bills

A NEW electric-spark photographic device for snapping split-second portraits of liquid spray droplets is a possible research aid in squeezing more automobile miles out of each gallon of gasoline The spray analyzer was developed by Samuel Gilman, research engineer at the Westinghouse Research Laboratories, who uses it to photograph water droplets one-thirtieth the size of the head of a pin It may be used by other engineers to study liquid sprays inside carburetors, Diesel engine fuel injector systems, milk evaporators, and similar machinery, he said.

"New automobile carburetors giving more miles per gallon may result from studies made with this apparatus," Mr. Gilman explained. "By using it, automotive engineers will be able to determine the exact size of gasoline droplets in the carburetor—and the fineness of the droplets influences the rate at which the fuel vaporizes. They will also be able to find out whether the spray is uniformly distributed throughout the carburetor."



Right: Camera set-up for analyzing liquid sprays. *Above:* "Portraits" of flying water droplets, "stopped" by a ten millionths of a second spark flash

Water droplets studied by Mr. Gilman are so tiny that they would evade the camera if ordinary exposures were used, so he takes the pictures in ten millionths of a second by means of a high intensity flash from a 5500-volt spark gap The camera points directly at the flash and the spray passes between them.

"What we actually photograph is the shadow of the droplets," he explained "The tiny particles cut off the light passing from the electrical spark to the camera and are recorded on the photographic plate as white dots These 'portraits' are enlarged 65 times by throwing their images upon a ruled screen where they can be measured easily.

"But before we got clear pictures of the particles we had to counteract the lens action of the droplets themselves We found that many droplets acted as little lenses, spreading the light from the spark gap and showing up on the pictures as tiny blurred lights whose actual size could not be measured

"This 'wild light' was tamed by putting a condensing lens between the spray and the spark gap. The condensing lens concentrated the light on the lens of the camera and kept the light away from all the droplets except those directly in the concentrated beam "

The droplets having their picture taken still act as lenses but the light they transmit is so feeble in comparison to the condensed beam from the spark gap that they appear black against it.

AIR DUCTS

Now Being Fabricated From Non-Critical Materials

SHORTAGE of sheet metal for the fabrication of ducts and casings used by the air conditioning industry has accelerated the development of substitute

Air ducts of composition board, with replaced metal duct in the foreground

materials for the conservation of priority products One such substitute is found in the use which Carrier Corporation is making of composition boards As a result of this development it is now possible to fabricate a duct system which formerly required 300,000 pounds of sheet metal with only 66,000 pounds of sheet metal, the remainder being composed of non-critical composition board

PARTS PROTECTION

Afforded by New Cellulose Wrapping

Rust, dust, and corrosion are silent but powerful enemies of a smoothly running war machine They are particularly damaging if they can attack before the parts are finally assembled and the weapon, instrument, or vehicle put to use Delicate shafts and gears made to fit to the ten-thousandth of an inch would be ruined by the thinnest layer of rust

Consequently these enemies must be continually guarded against during the fabrication and shipping of ammunition, guns, range-finders, tanks, planes, and spare parts Traditional protector against rust-inducing moisture has been a layer of thick grease, but it takes far too much time and labor to remove the grease, as any World War One soldier who was presented with a grease-coated rifle well remembers

In order to save valuable man-hours otherwise spent in such cleaning operations, a number of plants engaged on war equipment work are now using a new tough, moisture-proof wrapping material It is made of Du Pont cellophane film laminated to a light cotton fabric known as "scrim" and then impregnated with other moisture-proof materials. It can be sealed by twisting the ends of the package by hand or by using a heat-sealing device.

In view of the climatic conditions encountered in today's far-flung battle zones—the abrasive sands of Egypt, the high humidity of the tropics, the mists and rains of the Aleutians—protection of spare parts for airplanes and guns is of particular importance

The finished part or article may now be thoroughly cleaned of dirt and machining oils at the point of production It may then be wrapped in the cellulose material without any other protection against rusting, except a light coating of oil which in many cases need not be removed, or a lump of moisture-absorbing silica gel placed inside the wrapping

• • •

FUEL—Quantities of fuel oil and Diesel oil purchased by Class I railroads in the first six months of 1942 increased 28 percent, respectively, compared with the same period of 1941, reports of the Interstate Commerce Commission disclose

• • •

EAR PLUGS

Molded "To Measure" From Plastic

To provide relief from nerve-wracking noise in factories, defense plants, ship yards, foundries, and so on, an individually molded ear-stopper of smooth, translucent plastic or plaster of paris has been devised Reproduced from a special impression taken of each ear, the new ear plug fits the auditory canal comfortably and will not fall out under ordinary conditions

The impact of loud sounds and noise is reduced with the new device by as much as 40 decibels—or a diminution in sound power of 10,000 times—according to the makers, Maico Company, Inc Interest in the new product has been accelerated by the increased tempo of production in war plants and the resulting boost in noise-level intensity In addition, the expansion of precision operations and increase in over time work has made the adverse effects of incessant clamor much more noticeable Use of sound-muffling ear-stoppers is claimed to reduce the excessive fatigue and nervousness common to noise-harassed war plant workers

In use, a factory employee selects his "left" and "right" ear-stopper, inserts each with a simple rotary movement Thus in position, each plug extends a short distance down the auditory canal, while the exterior portion nestles in the concha of the outer ear A small, curved segment of the ear-stopper lies just behind the frontal fold (helix) of the ear in such a manner that the entire device is held securely, yet comfortably, with sufficient space for equalization of air pressures The ear insert can be quickly removed when desired, and is easy to clean by washing in soap and water or mild antiseptic

Impressions of the ear canals may be taken by physicians, dentists, or qualified technicians, using a special plastic material available from the Maico Company The molded impressions are boxed and shipped to the Maico laboratory where they are reproduced—dental inlay fashion—in plastic Each ear stopper is then highly polished to a glassy smoothness and delivered to the user.

Steps in producing made-to-measure ear plugs. *Left to right*: Outer ear and canal coated with oil, cotton plugging canal; placing the plastic with spatula; removing plug

INDUSTRIAL TRENDS

WAR-TIME PRODUCTION LINES

Now that pleasure-car production lines—symbols of American industrial ingenuity—have disappeared from the face of the earth, and automotive plants have been all-out for war for some time, it is interesting to take stock of this one corner of our industrial picture.

Probably no one private citizen is more qualified to speak on this broad subject than Alfred P. Sloan, Jr., Chairman of General Motors Corporation. Hence we will turn most of this page over to Mr. Sloan and, by direct quotes and paraphrase, present his keenly analytical views.

Citing the contribution which engineers and production men have been able to make in developing a wartime technology, and relating the part played by production management in promoting both quantity and quality in war material, Mr. Sloan says that General Motors production rates have been accelerated, engines have been increased in horsepower, guns have been simplified and given longer life and improvements have been made in tank construction, in airplane propeller design, and in the manufacture of shells. New devices have been developed, new characteristics built into old devices. Meanwhile, a sound basis has been established for continued advance in war production techniques.

"In past years the energies of American industry were focused on the development of a peacetime technology for the production of civilian goods, there was very little demand for war materials," Mr. Sloan states. "Consequently, there had not been developed techniques for the intensive mass production of war materials that is now required. What is taking place is the application of management skill and experience, gained from peacetime production for consumers, to the problems of turning out vitally needed implements of war. This, together with the application of newly developed methods, is creating a new technology of war production."

Acknowledging "the generous co-operation of other manufacturers and of Army and Navy technicians, without which much of this progress (in General Motors) would not have been possible," Mr. Sloan groups into four categories the results made possible through the application of industrial mass production techniques to the production of war materials: (1) savings in critical materials, (2) savings in production time, (3) savings in cost, with consequent reduction in the nation's expenditure for war material, and (4) improvement of product as based in part upon reports of actual experience with the product in the combat areas.

Citing results obtained in the manufacture of one type of machine gun as illustrative of the same manufacturing approach applied throughout General Motors war production activities, Mr. Sloan explains some typical accomplishments in achieving the objective of not only more and more weapons, but better and better weapons in the technical sense.

"Mass production begins with planning, involves the attainment of complete interchangeability of parts and finally requires the introduction of progressive processing and assembling. In the case of the machine gun example, it became possible through changes in manufacturing methods to double production in the same man hours, to cut costs to half the original amount, and to build additional quality into the gun. Through new processes, more plentiful materials were substituted for critical materials; the number of special types of steels required was reduced by two-thirds.

"Co-operation with machine tool manufacturers resulted in the development of new machines which greatly shorten manufacturing time, releasing operators and tools for other assignments. For example, side plates originally milled individually were pressed nine at a time. This process was later improved by stamping the plates on a punch press, using five men for the operation instead of 40, thus enabling one division to transfer 35 men to other vital operations. Vertical reamers and drilling machines now handle up to 12 gun barrels at one time. Electric riveting, replacing the conventional cold hammer method, halves the production time on the riveting operation while doing a much more satisfactory job."

Discussing the problem of maximum effectiveness of military machinery, Mr. Sloan says:

"Modern implements of war must be specialized in order to meet specific needs. Mechanical equipment intended to perform a particular duty must be of highly intensified design in order to give maximum performance in that one special service. This means that for duties other than those for which it was designed, an item of equipment may render, in comparison, mediocre or even inferior performance. In other words, a piece of equipment designed to operate at maximum effectiveness under certain conditions will not operate at the maximum under all conditions.

"This principle is illustrated in the utilization of the Allison liquid-cooled airplane engine, which, in certain designs of planes, is higly effective in medium altitude fighting, while the same engine with adequate supercharging capacity added, and in other designs of planes, is rendering equally effective service at very high altitudes. Yet the former combination would not perform effectively under the latter conditions, as any explosive type of engine loses power rapidly in the higher altitudes, which characteristic must be corrected for by some type of super-charger.

"In general, it may be said that in the engineering of military products, as in the engineering of automobiles and other peacetime products, the development, in a single unit of superlative performance on all counts and under all conditions is impossible. Extreme qualities in some performance factors necessitate compromises and lesser qualities in others. Viewed from another angle, this principle of selection is, of course, the very thing that makes possible the engineering of superlative performance in the specific area desired."

CORK AND KAPOK

Widely used in life-jackets and belts, cork and kapok are two imported products that have been hard hit by war. Work on replacing them with domestic materials is proceeding apace. How cork is being grown in the United States has been discussed previously in these columns; now come reports of a kapok substitute that, present indications are, will not only replace this import from Japan but will, in many uses, be found superior. This substitute is the floss of the common milkweed. As a lining for life-jackets and for flying suits it is warmer than wool, more buoyant than kapok. Other uses for this weed are in the offing, uses which promise to be of outstanding importance in wartime as well as peacetime applications.

—The Editors

Biodynes

A Miracle of Wound Healing and Tissue Repair—The Life Cell's Secret

LOIS MATTOX MILLER

The bio-physicist, Dr. George Sperti, of Cincinnati, was urged by a professional colleague to attend a medical meeting in Chicago, and since he had other business in the city, finally agreed He arrived at the meeting late and slipped into a seat in the rear of a lecture hall, which was packed with doctors.

Dr. Thomas F. P. Walsh, a surgeon of Mercy Hospital, Chicago, was lecturing, and illustrating his talk with lantern-slide displays of a woman patient burned when a gasoline stove exploded. Even that audience of case-hardened doctors shuddered; the burns were almost certainly fatal. But no—the slides unfolded the progress of the case, day by day, while under treatment with a new burn ointment therapy The surgeon commented on the amazing absence of pain. To the spectators' astonishment, the slides showed small islands of new tissue beginning to form in the burned areas within three to four days The patient went straight on to a rapid and complete healing and was hardly scarred at all

"If I hadn't seen these pictures," said one doctor, "I would have sworn that this was an incredibly fine job of skin grafting."

Dr Walsh ended his talk on a dramatic note·

"I feel impelled to tell you, gentlemen," he said, "that this emergency was even more extreme to me than these pictures may indicate, for this case was in my own family."

Dr. Sperti was the discoverer of the ointment used. This was its first piece of professional recognition. The lecture was as startling to the discoverer as to any other spectator, for the ointment had been tested only once before, and less rigorously. A nun working in Dr. Sperti's laboratory in Cincinnati was burned severely as a result of an explosion during an ether-extracting operation. As an emergency measure, fellow workers smeared on large quantities of an ointment with which they were experimenting in the course of cancer research. which is their real business. For some reason which no one could then—or can yet—explain, pain ceased immediately and the burns healed without scars.

Some of the most interesting cases treated have been reported in the scientific journals and supplies of the ointment were offered to doctors who might be interested in making further clinical trials and reporting their results. Several hospitals took advantage of the offer. The Chicago report on results was merely the first of many just as remarkable which have followed in a steady stream since. Dr. Walsh alone has used the ointment in 100 serious burn cases; the story of each is gratifyingly monotonous.

The magical ointment is full of biodynes (from *bios*, life; *dyne*, force) and you are going to hear a great deal about it from now on.

The use of the salve in treating burns is a minor aspect; the biodynes are much more important than that They are "intercellular wound-hormones," whose existence scientists long have suspected but never before proved. These hormones are discharged by injured cells to stimulate the growth, breathing, and reproduction of other cells. Thus, at last, science begins to understand the miracle of wound healing and tissue repair. More important still, the biodynes may explain the mysterious process of cancer growth.

Cells are the microscopic building blocks that make up all living tissue—plant, animal, human. Each individual cell behaves very much like the whole organism of which it is a part; it breathes, uses energy, grows, reproduces itself, and normally lives in complete harmony with its neighbors.

But sometimes certain cells, for no apparent reason, go haywire, get "all out of breath," burn up sugar energy, grow abnormally, and communicate this mad behavior progressively to adjacent cells. Generally, such chaos in the cell community describes the condition called cancer. Since the hormones which control cell growth have now been isolated, perhaps science may be able to use them to prevent, control, or cure cancer! This possibility is as yet remote.

The story behind biodynes is this In 1935, the Archbishop of Cincinnati established a graduate institute for scientific research (the Institutum Divi Thomae), choosing as its scientific director Dr. George Speri Sperti, co-founder and director of the University of Cincinnati's Basic Research Laboratory. Sperti was then only 35 years old, but already he had acquired a reputation as a brilliant scientific investigator. The new institute gave him the scope and opportunities he was looking for: the modern laboratory in Cincinnati and another for the study of marine cell life on the ocean-front at Palm Beach, a small but carefully picked staff of chemists, physicists, plant physiologists, biochemists; affiliations with a number of big hospitals for clinical research; and a major project—cancer research

Tackling first things first, Dr Sperti reminded his colleagues of a queer, half-understood factor in cell behavior When a living tissue is wounded, the adjacent cell communities snap out of their peaceful, leisurely routine and begin reproducing themselves at a furious pace Only after the destroyed cell-tissue has been replaced and the wound healed, do things return to normal Obviously, some substance must control, and at times stimulate, cell metabolism. What was it? Where did it come from? How did it work? Find that substance, Dr Sperti reasoned, and you may have the key to the innermost secret of cell behavior, and a clue to cancer growth

For more than a half-century scientists from Virchow to Carrel had speculated on the nature of these wound-healing agents, and in recent years had agreed that they were some kind of "wound hormones." The institute researchers resolved to try to isolate them so that they could be studied.

The first step was to injure living cells and watch what happened. But how can you injure such microscopic units without killing or destroying them? Dr Sperti proposed to use ultraviolet rays. Everyone knows that, in controlled doses, such irradiation is stimulating and healthful; that in large doses it can be harmful, even fatal. More than the healthful dose, and less than the lethal overdose, he reasoned, ought to produce just the right amount of injury.

For the next few years the scientists labored over the lights and the test tubes. Suspensions of yeast cells, cell-

tissues of chick embryos, lizards, fish, and animal livers, were exposed to the ultra-violet rays. After a predetermined degree of injury had been done, the wounded tissues were carefully washed in solutions Then the cells themselves were filtered out of the solution Now, if some chemical had been released by injury, it had to be there in that sterile cell-free solution

And it was! When other bits of living cell-tissue from a chick embryo were immersed in the solution, the furious speed-up of cell growth and reproduction was plainly visible under the microscope The life-cell, at last, had given up one of its most important secrets

Now the laboratory workers assailed living tissues with chemicals which have long been suspected as cancer-causing agents They also attached test tubes containing cells to the diaphragm of a loudspeaker; its vibrations caused mechanical injury the extent of which could be controlled. When injury was not too great, the biodynes were always there But when cells were too violently assailed by vibration, too much ultra-violet or whatever, there were no biodynes Why? Because biodynes are secreted by injured *living* cells, and not by cells that have been killed

The investigators now wanted to know more about the biodynes themselves One of the first things they learned was that there are different kinds of biodynes, serving different purposes. Some induce the growth and reproduction of cells, and thus play a major part in wound healing. These they named the proliferation-promoting factor Another type stimulates the cell's breathing, now called the respiration-stimulating factor. Still others are called the glycolytic biodynes, and cause the cell to speed up its consumption of sugar for energy. It is not improbable that the number of known biodynes will increase with further research, as was true of vitamins.

But what part do the biodynes play in cancer? In cancer the cells grow abnormally; cell respiration is depressed; and sugar is burned up by the process called glycolysis. Each of these things might indicate the abnormal presence or absence of particular biodynes: too much of the growth factor, too little of the breathing stimulant, too much of the glycolytic biodyne.

Here is the way Dr. Sperti presented the theory to doctors at the Third International Cancer Congress: "It seems clear from our researches that carcinogenic (cancer-causing agents have the power to injure large numbers of cells, *and to keep them injured over a prolonged period of time,* resulting in the secretion of a large and continuous quantity of growth-factor and an unbalance in metabolism. This, we feel, may be the cause of cancer"

Sister Mary Redempta, S.S.J., of the Institutum Divi Thomae, describing to Dr. George Sperti her results in the fractionation processes in preparing biodynes

Whether this theory will hold water, and—if it does—how the biodynes may be used to normalize the cells, are now the subjects of intensive investigations, both at the institute and in the medical clinics affiliated with it.

Meanwhile, the biodynes are being put to work on other fronts Dr. Sperti is impatient with investigators who allow newly-discovered knowledge to lie idle merely because time isn't ripe for its application to the big job "Look at the implications of your facts," he urges, "think how they may be applied along the lines."

That is how the biodyne ointment for burns was created. Obviously, the proliferation-promoting factor was important to wound healing, and particularly in burns where large areas of new tissue must be grown. But more than that was needed. Experiments have shown that burned tissue suffers from subnormal respiration. The respiratory-stimulating biodyne was needed also!

With growth biodynes obtained from injured animal and fish livers, and respiratory biodynes from yeast cells, the institute workers compounded the ointment for burns which has performed so nobly. Incidentally, it contains virtually nothing else but biodynes and a greasy base. Just why it relieves pain, since it contains no local anaesthetic, is still unknown.

One group of institute workers discovered another interesting application. Healthy skin is characterized by ample cell respiration, it loses its fresh and vital appearance as age, dirt, lack of sunshine, and so on, lower skin breathing. Moreover, the cosmetics which women use, according to laboratory tests, merely depress skin breathing further.

Does this mean that the ladies, for health's sake, should junk their creams and lotions? Not at all. Simply by incorporating the respiration-stimulating biodyne, the depressing effect of cosmetics on the skin can be offset.

The manufacture and sale of such

products, of course, will bring to the institute royalties which will be quite welcome for the maintenance of more important research. Does that seem strange? Not to Dr. Sperti's eminently practical way of thinking. While he was still an undergraduate at the University of Cincinnati, he invented (more or less because engineers said it couldn't be done) a K-va electric meter which measures accurately the huge power loads consumed by industrial plants, and a large manufacturer contracted to pay $50,000 for the invention. A few years later, when he was a full professor, he decided that the University's Basic Science Research Laboratory needed modern quarters and better equipment. At the time he was studying the application of physical laws to biological materials, and he was aware that existing processes for irradiating foodstuffs were unsatisfactory. They would put vitamin D in milk, for instance, but leave the milk tasting like burned meat. Dr. Sperti produced the solution: "selective radiation" which employs only the narrow band of vitamin-producing rays and filters out all others. In return for Dr. Sperti's patent, General Foods gave the University of Cincinnati $300,000 with which to start its basic research laboratory.

From these early experiences he evolved the theory that in scientific research, brains, imagination, enterprise are more essential than money: if your scientists have those basic qualities, and run short of funds, they can always turn their hands to making research pay at least a part of its own freight He has operated on that theory consistently. The institute draws royalties from his patents on fluorescent lighting, vitamin preparations, food preservation, meat tenderizing, and irradiation processes The Sperti sunlamp, which imparts vitamin D and tans the skin with almost no risk of burning, brings in $50,000 a year in royalties.

Today, the scientists on the staff, inspired by Dr. Sperti's example, often turn their minds to such practical problems after a day's work is done, and solve them as you would a crossword puzzle or brain-twister It's their form of relaxation—but it pays dividends.

Thus, in their spare time, they have discovered sources of natural rubber in Florida, and have produced from Florida seaweeds better agar than used to come from Japan. They have developed also a process for impregnating toilet soap with vitamin D which can be absorbed by the skin; and another that converts waste brewer's yeast into a cheaper. more nutritious chicken food. Recently, they have developed a method for sealing the flavor in coffee beans before roasting, which produces a more delicious coffee from 25 percent less grounds.

The Institutum Divi Thomae is supported by the Archdiocese of Cincinnati and private contributors, but income from inventions now covers approximately half of the expenses of its main laboratories at Cincinnati and Palm Beach, and its ten affiliated laboratories, whose staffs number more than 100 scientists, including students. Cancer research takes lots of money, and these Institutum scientists are proud to make extra-curricular contributions to its upkeep. Perhaps that is why one distinguished cancer specialist, inspecting the Palm Beach labortories last winter, made this remark: "Dr Sperti never reported his discovery of that other biodyne—the one that stimulates such loyalty and devotion in the human heart."

• • •

VITAGRASS

Yes, There Are Vitamins in Grass—But . . .

A NEWSPAPER item stating that common grass contains vitamins was printed and reprinted the nation over, a number of months ago, and still brings this magazine inquiries about the method of use This whole question has been neatly summarized in *Nutritional Observatory*, publication of the Heinz Nutritional Research Division of the Mellon Institute, Pittsburgh, Pennsylvania, according to the following quotation:

"The flavor, fiber content, and high water content of fresh grass are three reasons against its use, together with the possibility for eating noxious weeds that may grow with grass and escape removal in its preparation for use. It is necessary to limit the intake of fiber for convenience as well as for comfort, and also to avoid serious wastage of other parts of the diet through increased rate of peristalsis, mucous secretion, and bacterial activity.

"Man, unlike such ruminants as the cow, for instance, is not equipped with intestinal bacteria to handle large amounts of such bulky fare as fresh grass.

"Grass has now been suitably dried without destroying its nutritive property. One such preparation, a dehydrated cereal grass, made largely from young wheat, is getting increased notice. A bread in which dried cereal grass has been incorporated has gained some popular acceptance.

"Grass either fresh or dried is decidedly laxative for most human beings and care must be exercised in its use, especially if eaten in large amounts Probably the digestive system should be prepared gradually for consumption of grass. Not all individuals would be adapted to this kind of regimen, particularly the young, sick, and aged with delicate digestive mechanisms.

"The requirements for carotene (provitamin A), ascorbic acid (vitamin C), and iron can readily be met by eating moderate quantities of dried grass In the case of calcium and the vitamin B complex factors, as thiamine, riboflavin, and niacin, between four and six ounces need be eaten, amounts so large as to be undertaken only by an enthusiast

"Undoubtedly the wisest and safest recommendation is to use dried grass, if at all, in small amounts and finely ground, either as an added ingredient in common foods such as bread, or as a supplement to the diet in the form of tablets, which should be prescribed only on advice of a physician"

NO MORE MESS

New Superior Base for Ointments is Developed

OINTMENT bases that can be whisked from clothes or skin with plain water have recently been developed by pharmacists; greasy, messy ointments and salves may soon be out of your medicine cabinet Many formulas for the new type of ointment have been proposed, a few have been successful The most promising to date is announced in the practical edition of the *Journal of the American Pharmaceutical Association.*

The new ointment base was developed by Dr. Emerson C Beeler at the Washington, D. C laboratories of the American Pharmaceutical Association. Smooth and "washable," the base consists of cetyl alcohol, white wax, propylene glycol, sodium lauryl sulfate, and water.

The alcohol used is a giant molecule, compared to your rubbing alcohol. This makes it a white, wax-like solid. In combination with the "wetting" agent, sodium lauryl sulfate, it causes medicinal agents to penetrate the skin better. It is also greaseless and is said to make the skin velvety. It permits the heat of an inflamed area to escape more readily; discharged fluids are not sealed in as is often the case with greasy salves. —*Science Service.*

OUR *Point* OF VIEW

A LETTER—AND A REPLY

Midwestern State College

Dear Dad:

Yesterday being Women's Day on the Campus, Dean Rush, of University of Pittsburgh, gave a marvelous talk on the war and a girl's part in it. At dinner we all discussed the talk, what we haven't done, what we could do in the future, and agreed we haven't accomplished or sacrificed a single thing. The result is I am in a terrible state of confusion and I know you are the only one who can straighten me out The other girls in the house are bothered by the same feeling of helplessness Right now I should be studying for a geography location test, but all the time it seems as if something was hanging around my neck, and I can't shake it off or settle down to anything.

I have the feeling that all this studying is very unnecessary, that it isn't vital to the war effort in any way, that one can hardly plan on anything, even from day to day. Oh, yes, we are told they want the women to remain in college and prepare for the future, but it all seems so useless when the only future we can see looks dismal and unpromising. I know if I weren't in college I would be doing little more, if anything, to help, but when my own brother writes he is dropping out of school, as you know, to join the Marines, when other boys to the right and left of me are leaving for the armed services, I feel so infinitesimal. And helpless.

As for the future, what can we look forward to but depression and a state of readjustment which will change our mode of living more than we can imagine? The boys I know have two attitudes, neither of which help much. With them it seems to be a case of "eat, drink, and be merry, for tomorrow you may die," or, get all you can out of college, for the training and good marks will help to get ahead both in the Army and in the future. Actually, Dad, how many of the 18- and 19-year olds are going to buckle down and study hard when they know they will be called soon?

I know there is no answer to this, but I only wish I could feel more secure and settle down to work, and when I am all mixed up, how can I be expected to concentrate on such seemingly trivial things as the location of Azizia?

Love, Patricia.

P.S. Where *is* Azizia?

New York.

Dear Pat:

To answer the easiest of your questions, Azizia is some 20 miles south of Tripoli, near the northern coast of Africa. If I could truthfully and fully answer the rest of them, I not only could put all astrologers out of business, but also I could name my own price for the information.

However, perhaps I can offer a sort of mental sedative, or injection, consisting of one part hope, one part mental balance, and plenty of parts each of intestinal fortitude and faith in the American Way.

To try to be practical about it all, let's first admit that our world is very, very sick, and that it is going to take several transfusions, maybe a major operation or two, and a lot of careful nursing through the recuperative period before the world's pulse, blood pressure, and heart are once again somewhere near normal. To accomplish this will require the efforts of at least three, possibly four, generations of the earth's peoples, among whom Americans are destined to play major roles The transfusions and major operations must be accomplished by my own generation, part of the ones just ahead of and behind me, and a portion of yours When the surgical work has been completed, it will be far more the job for you, your brother, and all other members of your generation than it will be for people my age or those older than I to recuperate the world—to prevent it from sloughing into the "dismal and unpromising" future you mentioned

Your job will be the toughest. After all, transfusions and operations are primarily mechanical in nature. They require health, skill, and money. Youngsters of your age have an abundance of health. My generation can contribute a reasonable amount, plus skill and money. The men and women older than I can donate the skill derived from years of knowledge and experience, as well as money obtained from various sources.

But to guide a very ill world patient through convalescence calls for extreme patience, diplomacy, and a knowledge of many things, such as architecture, engineering, medicine, law, chemistry, physics, languages, economics, history, and, yes even the location of Azizias.

That's your job Yours and all members of your generation who may be blessed with the opportunity of receiving knowledge from our "intelligence factories"—our colleges and universities—both now and after the war is over It is to be hoped that your brother and as many members of his class as possible will be spared to return to college for the "know how" they will need to guide the destinies of America and the world. After the last war, I, like many others, didn't go back to school—and I've lived to regret it.

It is only by acquiring that "know how" that you and your classmates may be fitted for the job of bringing a recuperating world back to a state of health which will mean happiness to all That "know how," as always, comes from our "intelligence factories."

Above all, it is not a question of looking forward to "depression and a state of readjustment" It is a challenge to the young men and women of your age to prepare themselves to, if possible, prevent depression, or, if that materializes, to conquer it. As for readjustment, we are all going through that now, every day—and will continue to do so—to such an extent that it is problematical if we can be called on for any performance we cannot render Doubtless many Dads have to answer letters like yours, and I say for all of them to all of you—stick to your job of learning as long as you can. If you must give it up to protect your country, by all means go back to it as soon as you can. We shall need you and your knowledge.

Dad *(A.D.R., IV.)*

(The two letters printed above are copies of actual correspondence, with only minor changes, between an Associate Editor of this magazine and his daughter.—O.D.M.)

Star of A. D. 1054

An Unprecedented Physical Process in a Unique and Extraordinary Object

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

Two recent papers from Mount Wilson, dealing with the Crab Nebula, permit additions to the account which we gave last August.

It was already known that the Crab Nebula shows a strong continuous spectrum in addition to the familiar bright lines. Baade, photographing with color screens—one transmitting the red hydrogen line and the strong forbidden nitrogen lines close by, and the other including a region further in the deep red in which the spectrum shows no bright lines—finds images so different that they would hardly be taken for the same object. The first reproduction shows an intricate network of bright filaments on the original, remarkably rich in fine detail, superposed on a feeble continuous background. On the second the filaments are entirely absent, and there is only a diffuse image quite devoid of sharp detail and considerably smaller than the first. The star-images outside are about equally bright, so that this cannot result from under-exposure.

These remarkable photographs show that the nebulosity consists of two distinct parts, "an outer system of filaments, and an inner mass of amorphous structure." The line spectrum is evidently concentrated in the filaments and the continuous spectrum in the amorphous mass.

The filaments are conspicuous in the first photograph because the color-screen was deliberately chosen so as to transmit the light of the bright red lines, and cut off the continuous spectrum as closely as possible on each side, so that its light might not drown out the details. Baade estimates that, when the whole range of spectrum is considered, the continuous spectrum accounts for more than 80 percent of the light of the nebula.

This fine piece of observation opens the way to a fuller understanding of this remarkable object. Photographs with the first filter show the filaments much more sharply than the older ones in which they were half drowned by the continuum. Ten years hence, when new plates taken in the same way can be compared with them, we should have much more accurate determinations of the outward motions of the filaments than we have now.

At the same time, and at the same observatory, the spectrum of this nebula has been studied by Minkowski, both by observation and theory. The observations put it beyond any doubt that the bright-line spectrum comes from the filaments; for whenever a filament, as shown on the direct photographs, crosses the known position of the slit of the spectroscope, the bright lines appear. This bright-line spectrum is of the ordinary nebular type, with "permitted" lines of hydrogen and helium, and forbidden lines of oxygen, nitrogen, neon, and sulfur. The hydrogen lines are fainter than usual, and the nitrogen lines stronger; but it is evident that we have to deal with the now familiar situation in which masses of gas are illuminated with short wave ultra-violet light coming from a very hot star, and thus excited to shine by processes which are well known.

This hot star must be the remnant of the old super-nova. It is probably the "south-preceding" component of the faint double star near the center of the nebula. (The other component has a spectrum of the solar type, and is not hot enough.) Baade concludes, however, that the question cannot be settled decisively until the proper motions of the nebular filaments are better known. From these the motion of the point from which they were ejected in 1054 can be found. This should agree with the motion of the star, which is already pretty well determined; but, as Baade remarks, the mass of the nebula may be as great as, or greater than, that of the remnant of the star from which it was ejected, and therefore the motions of the two need not be exactly the same.

The star in question has the photographic magnitude of 15.9. Allowing for the distance of the nebula, and an estimated absorption of 1.2 magnitudes by obscuring interstellar matter, the absolute photographic magnitude comes out 4 8, or about twice as bright as the Sun

The brightness of the nebula is greater by about seven magnitudes —that is, it is 600 times brighter than the star which illuminates it, and 1000 times brighter than the Sun, visually as well as photographically, since the color is about the same.

It might seem at first sight absurd that the nebula should be so much brighter than the star which sets it shining; but this is what might be expected if the latter is exceedingly hot. All but a very small fraction of its radiation would then be in the remote ultra-violet, to which our atmosphere is opaque. The nebula acts as a transformer, absorbing much of this energy, and converting part of this into light of longer wavelength, which gets through the air to us.

It has been well understood for years just how isolated atoms can be stirred up to emit their characteristic bright spectral lines in this way, but the continuous spectrum is something new. It is certainly not due to reflected light from the central star—it is hundreds of times too bright We cannot get away from this conclusion by assuming that this nebula itself is almost opaque, and obscures more than 99 percent of the light of the central star, for the bright lines shifted toward the red, which must come from the receding gaseous filaments on the far side, are substantially as bright as those shifted to the violet, from the near side. The nebula is undoubtedly almost transparent, and its continuous as well as its line-spectrum must be formed within it by some process of transformation of the short-wave radiation of the central star.

Minkowski has proposed a very interesting explanation for this. Briefly, he suggests that the process which causes this faint nebula to shine is essentially the same as that which makes the gases of the Sun's surface appear as a luminous photosphere, and keeps the vast stores of heat inside the Sun from escaping faster than they do.

In the solar gases, even at the surface, there are a great many free electrons, removed from the various atoms. When such a free electron passes near a charged atom it may get by unscathed and recede at the

same speed; or it may suffer a transition to another orbit, and escape with diminished velocity; or it may be captured by the atom and remain bound to it. In the last two cases, energy has to be got rid of, and it escapes as radiation—not with a precisely fixed wavelength, as in the case of a transition between different states of the same atom, but with all sorts of wavelengths, depending on the circumstances of the transition. The light resulting from a multitude of transitions of this sort, analyzed by the spectroscope, gives a continuous spectrum.

It is now generally accepted that the continuous background of the spectrum of the Sun, and of the stars in general, is produced by transitions of this kind in the solar or stellar atmospheres, and the regions underlying them. In a star, the total thickness and quantity of gas is great, and the net effect, seen from a distance, closely resembles the surface of an incandescent solid

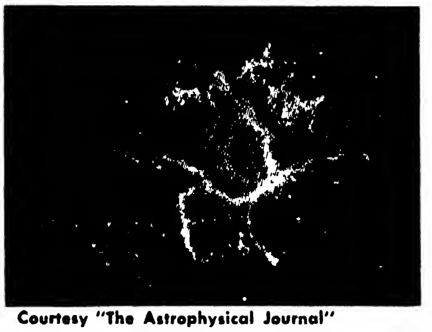
MINKOWSKI'S bold suggestion is that the excessively tenuous gases in the Crab Nebula shine by the same process There is no doubt that the atoms in these gases would be highly ionized by the influence of the radiation of the central star, and that the electrons thus liberated would undergo transitions such as have just been described when they come near the charged atoms The only question is whether enough light could be produced in this way to account for the actual brightness of the nebula

After a thorough analysis by methods too technical to summarize here, Minkowski concludes that this is possible and arrives at numerical results which, though approximate, should give a good idea of the general situation.

He finds that the nebula is 15 times as massive as the Sun This seems large; but its average diameter is four light-years, so that its mean density comes out 3×10^{-21} g/cm^3—or one pound in a sphere 4000 miles in diameter. This corresponds to 500 atoms per cubic centimeter, which is a thousand times or so greater than the density of the interstellar gas which pervades our part of the Galaxy. Hence the existence of the nebula as a luminous body is intelligible.

The amount of gas in a column a centimeter square, extending right through the center of the nebula from edge to edge, comes out 12 milligrams —or equal to that of a column of ordinary air of the same cross-section and four inches long. After full allowance for the higher opacity produced by the electron haze in the gas, it is evident that the nebula must be almost perfectly transparent to the light of the stars behind it.

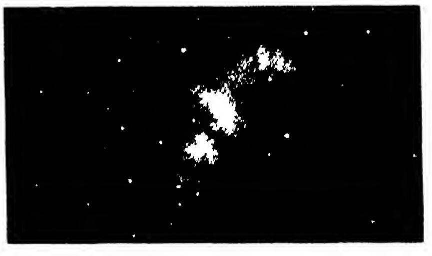
The central star which provides the power to run this extraordinary transformer of energy must be exceedingly hot. Only rough numerical estimates can be made, but Minkowski finds that all the known data can be reconciled



Courtesy "The Astrophysical Journal"

Above: Crab Nebula, λ6300—6700 (in the red of the spectrum)

Below: The same at λ7200—8400 (in deeper red and infra-red)



with a surface temparture of 500,000 degrees, a radius of 1/50 of the Sun's, and a total radiation 30,000 times the Sun's. Practically all this is in the extreme ultra-violet, and the transformation of a few percent into visible light accounts for the observable nebula In the outer parts of the nebula, where the atoms get down to more ordinary states of ionization, the bright lines would be emitted by the standard process.

This interpretation describes an unprecedented physical process; but it applies to a unique and extraordinary object, and is derived from our best present knowledge of the properties of matter Its author does not present it as *proved*, but as a hypothesis consistent with the known facts.

The most remarkable part of the picture is the central star, which is almost as small as a white dwarf, but excessively luminous and hot. The existence of such stars is not merely explainable theoretically, but was predicted years ago If a star contracts more and more, its central density must at last become so great that the matter approaches the degenerate state where further contraction will occur only under enormous pressure. The white dwarf stars are generally recognized as being degenerate throughout, except for a thin surface layer. There must be an intermediate stage where the core of the star is degenerate, but the outer half is still composed of normal gas. Such a star, though only two or three times as large as in its final state, would still be very hot on the surface Eddington—in discussion at a conference in Paris in 1939—stated that a star's surface would at this time be the hottest in its whole career and coined the name "blue dwarf" to describe it

HERE we have a star that appears to be actually in this state. The only trouble observationally is that it is not blue, but yellowish-white. However, when only a ten-thousandth part of the whole radiation of a star is found in the visual and photographic region, it is quite possible that some secondary effect may disturb the distribution of this minute fraction of the radiation, and modify the color.

The mass of this blue dwarf, if it is degenerate at the center, must be not much greater than the Sun's Here we meet our final difficulty, we must assume that in the super-nova catastrophe most of the mass of the original star was blown off into space, leaving only about a tenth—more or less—to settle down into a blue dwarf But even this has been predicted on general principles

In a degenerate mass of gas, when the velocities of the moving electrons begin to become comparable with that of light, the law connecting pressure and density changes Chandrasekhar has shown that, when this is taken into account, a star of small mass (less than twice the Sun's) will settle down into a permanent state with a degenerate core, as a white dwarf, and finally as a "black dwarf," cold on the surface; but a large mass (ten times the Sun's or more) can never become quite degenerate, but should continue to contract without limit

It is natural to suppose that something would ultimately happen to end this process, and it may well be that the contracting star blows up, ejects enough matter to leave a residue small enough to form a degenerate core, and then develops successively into a blue, a white, and a black dwarf. At the Paris Conference of 1939, Chandrasekhar suggested that some catastrophic change of this sort might be responsible for a super-nova.

This suggestion—at that time pure theoretical speculation—fits in remarkably well with these later data. — *Princeton University Observatory, October 30, 1942.*

Soil Saboteur

Selenium, When Present in Soil, May Kill Livestock, Poison Foods Raised for Human Consumption

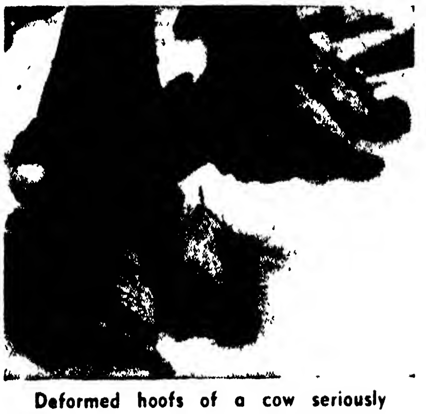
J. V. SHEPARD

A FARMER living in one of the Great Plains states walked into a doctor's office the other day complaining of vague gastro-intestinal symptoms and a persistent skin rash. Instead of proceeding with a physical examination of the patient, the doctor inquired whether his chickens were doing well and whether all his eggs had hatched this spring. In due time, the physician explained that there is a very real connection between sick poultry and sick farmers. Chickens, livestock, and human populations living in certain areas of the Northwest eat grains and other foodstuffs raised on soil containing selenium, an element as poisonous as arsenic.

Selenium poisoning first became a problem in the Northwest when that territory was opened up to homesteaders. These early settlers were baffled and dismayed by a strange affliction which deformed or killed off great numbers of their livestock. Many cattlemen thought the malady was caused by alkali waters, so it became widely known as "alkali disease." Finding themselves unable to cope with the problem, cattlemen and farmers turned to their agricultural experiment stations for government help, but it was not until 1929, after many fruitless and disappointing experiments, that scientific investigators got on the right track and started hunting down the selenium saboteur.

One of the first to prove that grains and plants in certain areas were toxic to animals was K. W. Franke, of the South Dakota Experiment Station, but he could not determine the exact nature of the poison. Finally, in 1931, the problem became serious enough to warrant federal aid. Dr. H. G. Knight, a government chemist, suggested that selenium might be the toxic principle in the grain. It was an inspiration straight from heaven, but it took Dr. W. O. Robinson, another government research man, to anchor that inspiration with some solid facts. In 1933 he successfully proved that selenium in the soil=selenium in plants=selenium in livestock=dead, poisoned livestock.

Selenium poisoning may be of a chronic or acute type, but in either event the effects are not pleasant to behold. Cows, horses, and pigs which have eaten toxic grains suffer from loss of weight, lameness, damage to heart and liver, and, most pitiful of all, a marked deformity of the hoofs which may eventually slough off. These animals are frequently in such



Deformed hoofs of a cow seriously afflicted with poisoning by selenium.

pain that they will remain in one spot and starve rather than attempt to graze on their sore feet. Cows with deformed hoofs have even been observed grazing on their knees in order to rest their deformed feet. In the acute form of poisoning, known as "blind staggers," the animals suffer from impaired vision and seem to lose all sense of direction. They wander about in circles, and when confronted with an obstacle, they will push up against it rather than attempt to detour. They frequently acquire a depraved appetite for such items as wood and metal. While the hoofs are not affected in this form of poisoning, the animals suffer from increasing paralysis and usually die within a short time.

DUCKS and chickens also have their troubles with selenium. The effects of the poisoning on adult birds are not very spectacular, but the effect on a chick embryo developing within a selenized egg is something really fantastic. The embryos are frequently deformed into such weird shapes that one might suppose Dame Nature had suddenly got all her patterns confused, cutting out peculiar birds with one eye, no wings, short legs that end in a single toe, and beaks much too short to pip the shell. Even when the chicks are not too deformed to hatch, they are born weak and decked out in a most unbecoming wiry down.

One of the most devilish things about selenium poisoning is its effect on animal fertility and the fact that it can carry over to the next generation. Experiments on laboratory animals have confirmed field observations that matings between selenized parents are frequently sterile and, even when conception does take place, there is constant danger of miscarriage or birth of deformed offspring.

WHILE the selenium problem has been most serious and persistent in South Dakota, Wyoming, and Nebraska, there are perhaps a dozen more states in the Great Plains area and the Rocky Mountain belt which have reason to be concerned with the problem. Actually there is not a continent in the world which is entirely free of the menace, for selenium has been found in wheat grown in Canada, Mexico, Spain, Argentina, Australia, New Zealand, Algeria, and South Africa.

In those states where selenium deposits are found in the soil, they are by no means evenly distributed over the entire area but are found associated only with certain geological formations. The foundations for our present-day selenium problem were laid as far back as 60 to 90 million years ago. During the Cretaceous per-

Laboratory result of injecting a healthy egg with selenium: deformity.

iod selenium-rich shales were deposited over wide areas of the earth's surface At that time there were no such things as cows and farmers and western wheat: only a few giant reptiles were on hand to witness the dark deed Nor was there any hint of a 20th Century drought in that area now known as the Great Plains, for it was submerged beneath a shallow sea To the west of this sea was a range of mountains which preceded our present Rockies. Geologists believe that active volcanoes in these mountains spewed out gaseous selenium and seleniferous ash which were blown out over the sea and combined with soluble iron compounds in the water These compounds remained in the earth when the sea finally drained away

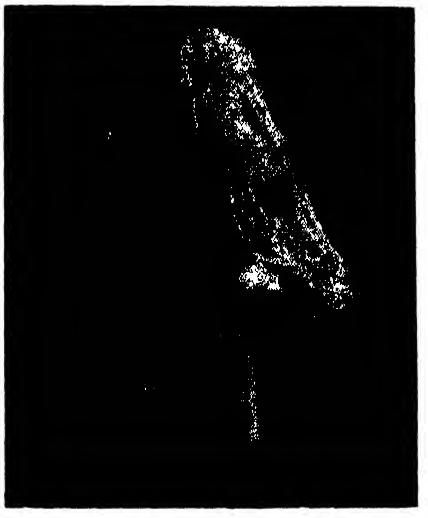
While the question as to the primary source of selenium is chiefly of academic interest the fact that selenium is invariably found in certain geological formations is of great practical importance here and now Wherever the geologist spots an outcrop of certain shales and limestones of the Cretaceous period, he can be pretty sure of finding seleniferous soil and can mark this area as a danger zone In fact, from a geological map of the world, it is quite possible to predict just where seleniferous areas will occur

Even after it has been definitely proved that the soil of a particular region contains selenium, it does not follow that the plants growing in that soil will contain a toxic amount of the element, for plants vary widely in their ability to absorb selenium Furthermore, selenium occurs in three chemical forms: chiefly as basic iron selenite, an insoluble form available to only a limited variety of plants, less frequently as calcium selenate and organic selenium, which are available to all plants The most notorious selenium gluttons are flowers like the vetches woody aster, and prince's plume, which grow in colorful profusion throughout the cattle- and sheep-raising sections of the Northwest. These plants look deceptively beautiful and harmless, but let the bovine diner beware! Such floral fare is responsible for livestock losses estimated at millions of dollars annually

Selenium-accumulator plants are doubly dangerous in that they are able to convert insoluble selenium into water-soluble compounds of the element and return it to the soil in a form readily absorbed by farm crops

But the career of a selenium-accumulator plant is not all evil. Because they grow only on toxic soil, they help investigators spot selenium outcrops and map off the areas dangerous for farming and ranging.

If livestock alone were the victims of selenium poisoning, our story would be tragic enough, but there is reason to believe that human populations in certain rural areas are consuming toxic amounts of selenium in drinking water, cereals, vegetables, meat, eggs, and milk Foods produced in seleniferous areas should be carefully analyzed and the final market products checked for total selenium content Brief public health surveys have been conducted in the most seriously affected areas, but much work remains to be done Local physicians in these areas are learning to recognize symptoms of selenium poisoning and should be requested to report all cases to state or federal authorities



Chick embryo found in egg laid by a hen poisoned with selenium

The selenium problem, for all its discouraging aspects, still has its bright side, for there are several methods of control which reduce the danger to a minimum Highly toxic areas may either be fenced off or planted with non-food crops which are to be used in industrial products In one section of South Dakota the government has already withdrawn 100,000 acres from cultivation In other places it may be sufficient to destroy selenium-accumulator plants and to raise alfalfa or other forage grasses which do not absorb toxic amounts of selenium. Whereever proper irrigation and adequate under-drainage are available, much of the selenium can be washed out of the soil and drained away.

Research workers have long been trying to discover a possible counteractant for selenium poisoning. Dr. A L. Moxon, of the South Dakota Experiment Station, has found that arsenic compounds are effective in protecting laboratory animals against selenium, but the dosage has not yet been standardized for practical use on the farm. Tolerance levels of selenium for livestock feed have also been determined so that farmers in the toxic areas can have their grain analyzed at the state laboratories to see whether it contains a dangerous percentage of selenium

Having taken adequate precautions to protect hen and horse from selenium poisoning, it would seem only reasonable to establish tolerance levels for the human animal and to enforce these standards by government inspections. The agricultural experiment stations have done a splendid bit of work in routing out the cause of soil sickness and in pointing the way to eliminate the danger

AGAR

Source Found in Puerto Rico

Discovery of a bountiful source of algous materials suitable for preparing agar, the indispensable fungic and bacterial culture medium used in every hospital and biological experimental laboratory, for years a Japanese monopoly product, may prove to be a significant result of ten months spent in Puerto Rico by Dr Hugo L Blomquist, chairman of the Duke University botany department

Already agar is becoming more difficult to procure and, with the Japanese and other oriental sources closed, laboratories will have to look elsewhere for supply Professor Blomquist reports that he has located several types of seaweed from which satisfactory agar-producing materials might be obtained

Agar is unique in that while bacteria and fungi flourish in its gelatinous mass it is not consumed or destroyed by it Dr Blomquist, an authority on grasses, algae, ferns, and mosses, became interested in the probable origin of several unusual specimens of tropical seaweed while at work during recent summers at the Duke Marine Laboratory at Beaufort, North Carolina. Following severe storms and several hurricanes, the shore became littered with the strange specimens, now taking on an important aspect

Going to the University of Puerto Rico in August, 1941, as exchange professor, Professor Blomquist began to look for the tropical seaweed, but it was only after Pearl Harbor that the search and final discovery of abundant areas of growth gave the routine scientific investigation practical importance

Glass, Present and Future

Applications of Glass to Unusual Purposes Reveal Interesting Possibilities for Further Development

R. A. MILLER
Pittsburgh Plate Glass Company

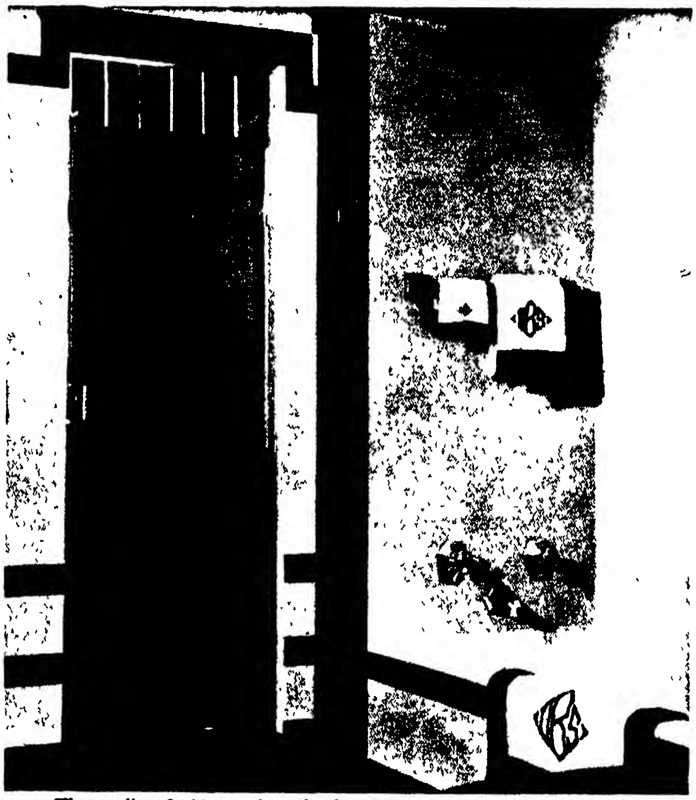
THE glass industry offers a diversity of opportunity for the adaptation of its product to human needs, needs emphasized as well as created by the war. Developments over the last ten-year period have altered general conceptions as to the fragility of glass. Now glass is utilized in many places where previously its tendency to break had precluded the possibility of such use.

Obviously, in this time of stress, military objectives are the chief concern Factories are being converted in every way possible to the production of military materials, and many civilian needs must remain unsatisfied As a result, careful consideration of consumer requests and desires may, and probably will, develop many new fields in which glass products can be used to the satisfaction of all concerned

Automobile tires cannot be made from glass, but tight catch basins for shower bath installations are possible. There is no satisfactory glass hand grenade, but satisfactory orifice plates of glass for use in the metering of gas and other fluids have been made. Perhaps there will be no request in the near future for glass dance floors, but the fact that they can and have been built, indicates an increasing sense of the utility of glass as an engineering material.

In the war effort, glasses have been developed which will stop .50-caliber bullets effectively. Such impacts will tear off a man's leg or arm. Today, bent laminated glass housings for pilots and bombardiers on bombing planes are being fabricated. A year ago they were believed to be impossible to make, but are now wholly acceptable to the armed forces. Special bombardier windows are now made for aircraft in bent laminated safety glass. A year ago, it was believed impossible to supply such windows in normal plate glass.

The widespread casualties resulting from glass blown from its frame by bomb explosions have emphasized the necessity for providing adequate protection against that hazard. Under most conditions, tempered plate glass and laminated safety plate glass afford the maximum protection obtainable. Wire glass gives reasonably good protection, but involves a hazard of serious injury from flying chips and particles when the debris is being cleaned up. There are different materials on the market which will afford a degree of protection from flying glass, dependent upon the thickness of the film applied to the glass, its adhesion to the glass, and the tenacity of the film itself. It is impossible to evaluate any of these materials, and any such evaluation probably will not be accomplished. Suffice it to say that ordinarily the thickness of films should be materially greater than a single coat, and should approach very close to .030 inches.



The walls of this modern bathroom are of Carrara glass, the door of the shower stall of Herculite tempered plate glass

New and suitable applications for glass products are being sought, and some more recently uncovered are quite unusual. A notable application is a glass vault; an attempt is also being made to construct caskets entirely of glass. Several glass or glass-lined bathtubs have been built in various parts of the country. Principally these have been made of tempered plate glass, and it is proposed that the burial vaults be of the same material. Self-supporting glass shelves, requiring only a few screws to hold them in place, are an immediate possibility Tempered plate glass mirrors are available in essentially the same forms as normal glass mirrors, and with the further advantage that there will be no hazard of flying glass resulting from bomb explosions. Recently, the adaptation of mirrors to the exterior of strategic buildings, as an effective means of camouflage, has been suggested, but whether or not its value is sufficient has not been determined. Invisible or non-reflecting glass in large areas is still a dream of the future, but treated glasses affording these characteristics, on small areas, especially in optical instruments, are gradually becoming available.

Tempered plate glass kick-plates on doors have been found to be satisfactory. They are obtainable either as enamelled tempered glass or as the clear or sand-blasted product.

Numerous everyday uses of glass offer themselves for consideration. In many instances only the fringes of the realm of possibility have been explored. Wider use of Nucite chalkboard in school rooms in increasing volume is possible, while applications of mirrors in homes has by no means approached a saturation point. Many people will recall having seen a considerable display of corrugated glass washboards. It seems entirely likely that the field for this item can again be exploited to a large degree

One interesting application of tem-

Carrara glass plaques make attractive centerpieces or appropriate bases for small objects

pered glass louvres may be found in the cooling towers of ice factories, breweries, and many other industrial works where water must be cooled by atmospheric evaporation. At least one such tower has been erected in western New York and serves as an outstanding landmark and advertising means for a prominent ice company in that territory.

The tanning industry is another field that offers wide possibilities for the use of polished plate glass, in the form of slabs for "tacking" hides, a process used in virtually every tannery throughout the country Glass has only just begun to invade this industry, and the potentialities appear enormous

EVEN though there has been a very definite curtailment of private building construction, still there should be available many opportunities for the distribution of glass plates as the lintels of windows, especially in kitchens and other places where various utensils are habitually placed on the window sill. The potentially large volume of business in the use of tempered plate-glass dresser tops for kitchen cabinets and other household equipment of a similar character should not be overlooked Desks in children's nurseries may be protected against damage to the writing surface by a tempered glass cover A piece of tempered flesh-tinted glass brings out beautifully the grain of a mahogany or oak desk.

In this enlightened age there are many homes heated with more or less unsightly steam or hot water radiators. The tops of these radiators offer an outlet for structural glass shelves Inking plates on printing presses; glass covers on end tables to prevent unsightly rings caused by the overflowing cup; window ventilators; wind screens on porches; and cigarette or cocktail trays, all offer potential or present markets. Tracing tables in drafting rooms, mantel mirrors in the living room, direction signs, air-raid protective glazing, and crane cab windows, are a few suggestions for expanded use of glass, already tried and found satisfactory.

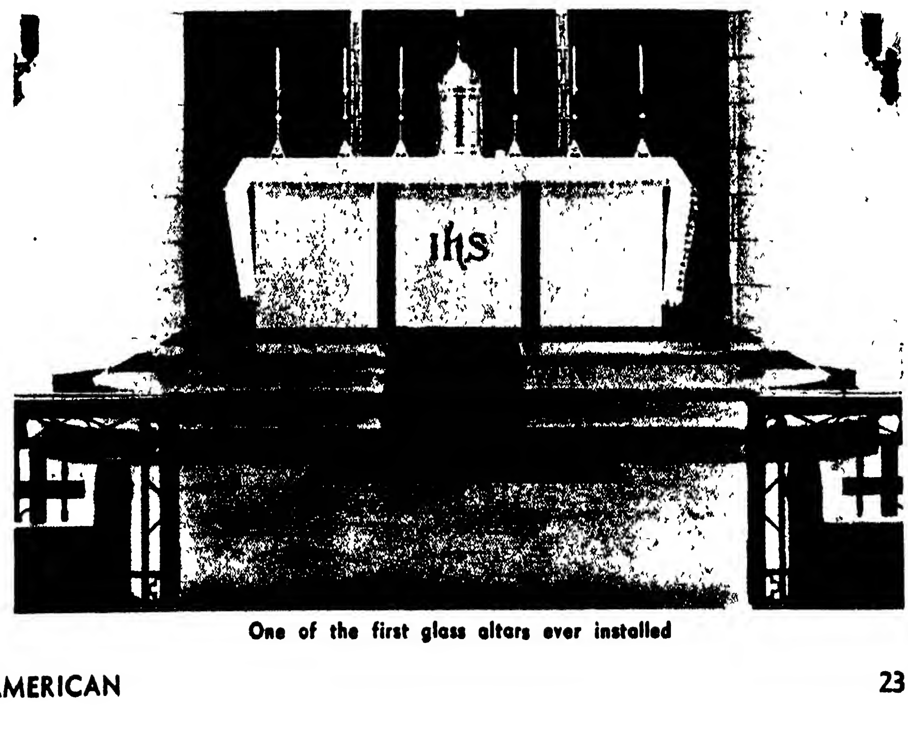
In this day of rationing, kitchen reminders comprising a mirror and a sandblasted section upon which the desired items may be noted, appeal to the housewife. Blocks of Nucite are suitable materials as knife sharpeners. Glass fire screens serve all the purposes of the now unobtainable wire or bronze screens, and the support may be made of hard wood blocks. Of course, these screens should be tempered plate glass.

Glass blocks merit careful consideration as a means for expanding sales. The utility of the small glass block banks as repositories for accumulating funds for the purchase of war bonds and war savings stamps should not be overlooked. Glass blocks definitely offer a means for satisfactory glazing without having recourse to any of the types of sash commonly used in the past, and no strategic materials need be consumed. Glass surface plates for use in machine shops and tool rooms will afford surfaces more than comparable in accuracy with the metal plates previously used.

Recently a man suggested an aerial glass fort, consisting of a huge star-shaped glass parachute with smaller star-shaped glass parachutes suspended from each corner of the larger one, and again still smaller glass forts suspended from each corner of the smaller parachutes. He proposed to tow this thing up into the air with airplanes or other similar tractor means, and then depend upon the wide expanse of the glass parachute to offset the effect of gravity and maintain the fort suspended in the air Another chap has suggested the coating of the exterior of submarines with mirrors so that when they came to the surface, one would see the reflection of the waves rather than the contour of the submarine proper. It might work, you know, but is highly problematical! The suggestion of camouflaging buildings with mirrors probably falls into the same general category as this last proposal.

THERE seems to be a definite possibility that large glass plates may be used as wholly satisfactory reinforcing means in concrete structures in lieu of the previously employed steel rod, which is now unavailable. One advantage of this material would be the reduction in the total weight of a given beam to carry a given load, since the density of the glass and that of the concrete which it displaces are about the same. Some reduction in thermal stresses should also result, since the coefficients of expansion of the two materials are very nearly alike. It is an idea which will bear considerable inspection and development work.

Another outlet of potentially great volume would be the lining of various types of chutes with glass plates, either



One of the first glass altars ever installed

shaped or in the flat form. Heretofore the cost of glass in comparison with other materials has precluded its use, but in view of the fact that problems of rusting, and the consequent speeding up of abrasion, will be eliminated, it is probable that glass will show a life comparable to steel and other materials which will more than justify the extra cost. The use of glass for the surrounding casing on various types of household furnaces, is another idea being studied.

• • •

GLASS WALLS

Now Available In Portable Form

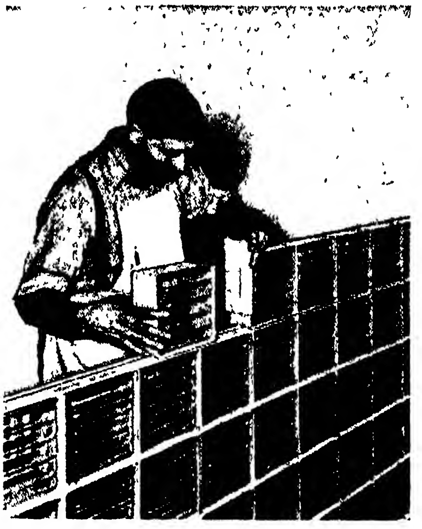
A WAR-INSPIRED improvement in partition construction, which uses only wood and glass, is facilitating the quick subdivision of existing homes and offices to permit their additional occupancy and more efficient use. The

Frame, A; moldings, B and C; wedges D

improvement, announced by the Owens-Illinois Glass Company, is a packaged glass-block interior wall, consisting of prefabricated wood strips and Insulux glass blocks Demountable at will, all materials in the wall are salvageable for use in remounting the wall elsewhere, or in different dimensions. The blocks are eight and twelve inches square and four inches thick, set in the wall on edge. The wood strips are ridged on their sides so as to groove into the corrugated edges of the glass blocks The strips are profiled so as to interlock with each other.

The whole wall, once put up, then is locked up with coupled wood wedges around the sides and top.

With this development, houses need no longer be constructed with permanent interior walls. A house with only its outer walls can be considered ready



Setting up a portable glass wall

for occupancy Its occupants can move in with their portable walls as a part of their belongings The layout of the rooms then becomes a part of the decorative design of the new occupants Each year--or at will--the room arrangement can be changed

In the case of a war factory needing additional administration offices, walls so readily constructed or moved, and furnishing all the inherent light-transmitting properties of glass, plus privacy, to the otherwise darkened interior of the plant, are indispensable where additional employees are crowded into an established office, rooms can be subdivided in much the same way that rooms in homes are added to accommodate war workers

GRAIN PESTS

Insects Require Intensive Control Measures

THE shortage of storage space for a large part of the tremendous grain crop is resulting in use of many makeshift temporary structures, which accentuates the problem of insect control, cereal pests in flour mills, warehouses, and other storage places normally costing the nation nearly a third of a billion dollars annually.

Examinations in Oklahoma, for instance, made over 23 widely scattered counties, show that an average of 42 percent of all stored wheat in past years was infested with some form of harmful insect.

In most grain storage structures, contact sprays, when properly applied, reduce the number of necessary fumigations. Contact spraying is helpful in freeing both regular and makeshift structures from insects before the grain is put in for storage

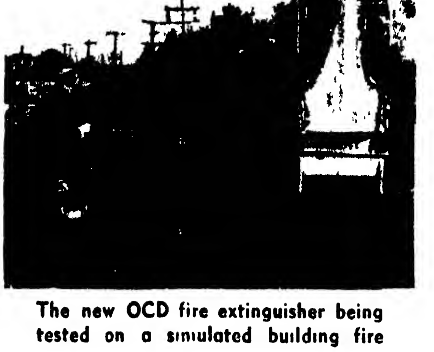
These contact sprays usually consist of a specially refined odorless petroleum oil, which acts as a carrier and solvent for toxic materials that are deadly to insects. While pyrethrum is the toxic ingredient in many sprays, it is now being supplemented by a synthetic compound derived from castor oil and known as isobutyl undecylenamide or by the more pronounceable name of IN-930. Du Pont chemists, who developed this compound, say it is replacing a substantial portion of pyrethrins previously required for an active base, and is not only more efficient but is more stable and easier to standardize

OCD EXTINGUISHERS

Now Being Turned Out By Thousands From Many Factories

THOUSANDS of new fire extinguishers to be used by OCD workers in fighting incendiary bombs and fires started by bombings are now coming from factories in the east, the middle west, and the west It was recently announced by Underwriters' Laboratories, Inc, after completing an inspection of the production at many of the twenty-odd factories where the extinguishers are being made, that test equipment and inspection programs have been set up at most of the plants The Laboratories will test the extinguishers and label those that meet the specifications

The extinguisher type decided upon, and now in production, uses water—the best all 'round and most plentiful fire extinguishing medium The device consists of an iron tank which is galvanized to prevent it from rusting.



The new OCD fire extinguisher being tested on a simulated building fire

The tank holds four gallons of water In the tank is installed a hand pump to which is connected a ten-foot length of hose with a nozzle on the end equipped with a deflector so that a solid stream or a spray may be had

The essential difference between the new OCD type of water extinguisher and the type which has been used by fire departments for many years is that

the former is made almost entirely of non-strategic materials.

The pump of the OCD extinguisher, instead of being made of brass, is made of steel tubes coated inside and out with porcelain—a radical departure from previous construction. The piston, piston rings, stuffing box, and valves of the pump are made of plastics. Glass marbles serve as valve balls. Such parts were formerly made of brass.

The ten-foot length of hose attached to the pump is made entirely of reclaimed rubber, no crude rubber at all being used for this part. The nozzle on the end of the hose is of plastic which will withstand hard abuse without breaking.

The extinguishers have been designed with a tapered tank so that they may be "nested" to conserve space in being shipped to the various parts of the country where they will be used. They will be shipped disassembled, to be assembled at their destinations by the OCD personnel to whom they are assigned.

• • •

LINGUISTICS—There are more than a thousand distinct languages now spoken on earth, without considering fairly diverse dialects.

• • •

LOW-GRADE ORE

Being Utilized by Means of Chemical Balloons

CHEMICAL "balloons" are now lifting, from low-grade minerals which were once disregarded, quantities of vital copper, zinc, lead, nickel, tungsten, chromium, and other strategic metals for military production, according to E. I. du Pont de Nemours & Company.

Working of low-grade deposits formerly thought of little value is made possible by so-called froth flotation Chemicals with an affinity for the grains of ore lift them in a bath from the worthless "gangue" or residues with which ores are associated in the earth.

Copper and zinc for shells; lead for bullets; copper for wire in motors, communication, and power lines; vanadium; nickel; tungsten and molybdenum for special steels; manganese; chromium; and a host of other vital metals are now obtained by froth flotation.

Flotation agents have been used for many years, but new chemicals developed in recent years have improved the practical and economical recovery of ores from low-grade mineral deposits. In mining camps of the United Nations enormous loads of low-grade ore ground in water flow daily into boxes, called cells. Minute amounts of chemicals are mixed with the ore.

The chemicals attach themselves selectively to the grains of the valuable minerals, and air bubbles lift them to the surface. Then the precious minerals are scraped or skimmed off the surface. Subsequent smelting and refining give important metals that go into implements of war

SCABBARD

For Bayonets, Is Made of Plastic

A NEW bayonet scabbard made of Tenite, a tough plastic material produced from cellulose acetate butyrate,

Light-weight scabbard of plastic

is now being issued to United States troops throughout the world. This scabbard is exceptionally light in weight, as compared with the ordinary type constructed principally of wood and leather, yet is strong and durable It is particularly satisfactory for hard service in all climates.

• • •

RUBBER—If automobile and truck owners of the United States were to turn in an average of one worn-out, discarded tire each, a 435,000-ton supply of rubber scrap would be provided.

• • •

ANTI-FREEZE

Boils at High Temperature, Prevents Rust

AFTER having been proved in use over a test period, a new radiator anti-freeze, known as No-Freeze, has been placed on the market. It protects cooling systems against freezing down to 35 degrees below zero and has a boiling point of 324 degrees, Fahrenheit. Made of non-critical materials, it is stated that No-Freeze does not contain inorganic salts and will prevent rust in an engine cooling system.

ELECTRON MICROSCOPE

Progress Report Reveals New Horizons

THAT the electron microscope is playing an ever-increasing role in the war effort, is found in a recent announcement that 43 of the RCA instruments are now in use where they will be of greatest service in bacteriology, chemistry, and metallurgy. Seven of these instruments are installed in England Scientists of RCA Laboratories, in reporting on their electron microscopes' performance to date, list the following 12 outstanding discoveries and accomplishments:

Photographing of influenza virus

A considerable amount of secret work is being done on the development of polymers as applied to plastics and especially to artificial rubber.

New light has been thrown on the texture of textile fibers which may lead to better and longer-life tires, also longer-wearing, warmer clothes

Study of bacteriophage virus and its destructive effect on bacteria

Finding of unusual and unclassified crystal growths which the light microscope has been unable to resolve Since the microscope is able to focus to a great depth even at low magnification, it is possible to study crystal structures which could not be resolved heretofore.

The study of surface structure of metals by the replica method, resolving detail unexplored by the light microscope.

Stereoscopic micrographs are made possible by the extremely high resolution and depth of focus of the electron microscopes, producing images with third dimensions.

Through the high resolving power and large depth of focus of the instrument, accurate calibration of magnification is possible, so that particle size and distribution can be determined

Photographing of plant virus, such as the tobacco mosaic virus, and the study of anti-serum in the control of these viruses.

Discovery of the fact that virus particles have internal structures as found in the vaccinia virus.

Recording of the action of germicidal agents on individual bacteria.

Adaptation of the electron microscope to production control is becoming increasingly important. For example, control of production of paint

pigments by the use of the electron microscope has resulted in a great improvement in pigments of all types from paints to inks.

CERAMICS

Take on Added Duties in War-Time

A scientific industry as ancient as man yet as modern as today is coming into its own—and may yet prove to be one of the saviors of the American standard of living in this day when nothing short of an A-1 priority can buy even a tin can—according to one of its foremost Chicago exponents, Dr H. G Fisk, mineral technologist at the Armour Research Foundation. The industry is that of ceramics, which began as an art rather than a science centuries ago when primitive man first formed crude utensils from the clay found near his aboriginal home Dr Fisk states:

The ceramics of today is a far cry from those early clay dishes Even before war took metals out of circulation, ceramic raw materials were involved in 70 percent of all industrial chemistry operations; they were fundamentally basic in the processing of most metals and an integral part of such sciences as radio and electrical engineering

Since Pearl Harbor imposed rationing upon the American scene, however, ceramics is daily becoming more important than ever and is well on its way toward a degree of importance it has not known since the advent of the metal age

Modern ceramics, too, is a far wider science than mere clay modeling. In its broadest sense, it involves practically all non-metallic minerals

And that is the basis for its special importance in war-time, for non-metallic minerals along with plastics are the only answer to the plaguing question of replacing metals needed in war production.

Silicate products—principally glass—are the basis for a large portion of ceramic articles—glass for window panes as well as the precision mirrors and lenses of modern optical instruments, glass made into dishes said to rival fine eastern china in beauty. And now, glass is being put into use once again for food containers, for shipping oil and other fuels. And modern improvements in annealing are making it practical.

Glass insulation was successful even before the war—but war's stimulus makes it almost a "must." Glass wool, for example, used in insulating a battleship, cuts down the weight by some 50 tons, and it is fireproof and vermin-proof.

Another new use for glass is in marking airports and military highways. Tiny glass beads imbedded in the surface of markers reflect even a weak light into a guide for fliers or caravans.

A second common and fundamental ceramic product is enamel, which today is experiencing a come-back as a replacement for aluminum. Aluminum once replaced enamel in the manufacture of kitchen utensils, hospital instruments, and other common containers, and gained immediate popularity because of its greater lightness. Today's superior enamels, however, placed over a stronger and thinner base metal, rival even aluminum.

Enamel has also been introduced as a lining for water and steam pipes and hot water heaters since copper has joined the list of vital metals. And enamels are even used on bricks and other construction materials to aid in withstanding the elements.

Another fundamental use of ceramic products is for abrasives. The present day machine gun, for example, requires 32 different grinding operations before it acquires the precision for fir-

ing against the enemy. And the abrasive wheels used in those grindings are the modern descendants of the old grindstone--made to run at speeds at which the latter instrument would have flown into a thousand pieces.

Made from fused alumina, formed from bauxite deposits too poor in quality for extraction of pure aluminum, the modern abrasives are hard enough to grind the finest steels to precise measurements Other abrasives still harder are made of tungsten carbide and boron carbide

Corundum—either synthetic or natural - is also used for sapphire jewels in precision bearings for time bombs and split-second airplane instruments

Other ceramic products vital in today's industry are magnesium oxide and similar products used for refractories in steel and oil industries, graphite used for molds in metal castings asbestos for insulation, shingles, and heat-proof suits and gloves, quartz in radio manufacture, kyanite for refractories and, recently, low grade topaz found in the United States, now used as a substitute for kyanite, formerly imported from India, pigments for paints, quartz sand used in sandblasting, and various and sundry types of bricks used for construction to replace lumber.

Many of these products were vital long before war created unusual circumstances. But all of them have taken on unusual significance during recent months and will become more important as long as the war lasts, in the opinion of Dr. Fisk

PENCIL DRAWINGS

Made on New Board Can be Blueprinted

COMPLETELY satisfactory blue prints can be made from pencil drawings provided the drawings are made on a surface which permits the drawing of hard, clean lines. Such a surface, applicable to any drawing board, has recently been developed by the W. H. Long Company The surface, called the No-Ink Top, is a specially processed white composition 1/8 of an inch thick, which is to be permanently glued to the drawing board. Drafting tape is used in place of thumb tacks to hold the drawing in position and a 3H or harder pencil is used

The resiliency of the surface allows the drawing paper to be indented under pressure of the pencil. All lines are drawn with a double stroke, the result being that the shallow indentation made by the first stroke is filled solidly with lead on the back stroke. Thus is produced an opaque, evenly-edged line which is virtually as clean cut as an inked line.

Although the surface of this new drawing board top yields to pressure of the pencil, all indentations disappear immediately; even needle holes made by the compass close up and disappear

SHOP GLAMOR

Preserved by Design of Welding Clothes

THE PROBLEM of how a woman can carry on a welding job safely and still look feminine has been solved by new-

For the form divine

ly designed tailored leather garments, of the type shown in one of our illustrations. Said to be the first clothing of its kind to be shaped to women's curves, this new safety clothing was designed by American Optical Company engineers to protect against dangerous flying sparks generated during the welding operation. The tailored leather garments, plus leather gauntlets and cap, welding helmet and safety goggles—not to mention lipstick—complete the protective ensemble.

FIREPROOFING

New Plaster Will Withstand Bomb Fire

TYPICAL uses of a new fireproofing plaster are protection against incendiary bombs, prevention of the upward spread of fire in a basement, fireproofing rooms, and so on. This plaster, made by the Paprex Company, is applied directly to wood, concrete, metal, glass, and standard plaster surfaces to a thickness of 3/8 inch. It dries in about four days, after which time it will withstand direct exposure to a blow-torch flame at 2200 degrees, Fahrenheit, for 20 minutes.

Having a consistency of tacky dough when dissolved in water, this new plaster is made from non-critical domestic materials.

• • •

STREETS—Street costs in American cities have been going down since 1930, analysis of reports of cities with 100,000 or more population discloses In 1930 a total of $139,323,000 was spent on streets by the cities in the 100,000 group, which amounted to 8 percent of total expenditures. In 1939 street expenditures by the cities had dropped to $116,444,000, a decline of 16 percent

• • •

PRIMITIVE NAVIGATION

Methods Relied Upon by Solomon Islanders

NATIVES of the Solomon Islands use "spiritual aids to navigation," according to an exhibition in the department of anthropology at Field Museum of Natural History, Chicago.

Radio direction finders, periscopes, and other modern aids to aviation and navigation are commonplace in the Solomon area since the navies and air forces of the United States and Japan have come into conflict with each other there However, the primitive natives of the region, who make long voyages in their large war and trading canoes, place their faith in grotesquely carved wooden figures in semi-human form These are placed on the bow of a canoe, just above the water line, in a position in which they seem to peer down into and through the water with vigilant eyes that never blink from fatigue The Solomon Islanders regard these images as representatives of a protecting deity, a spirit which is supposed to watch for reefs, rocks, and all other hidden dangers of the sea, and to guide the vessel away from such perils.

The natives place the same confidence in these inanimate lookouts that we place in living seamen, especially trained to watch and listen from forepeaks and crow's-nests, aided by the most up-to-date mechanical devices to locate the approach of danger

INVISIBLE RAYS

Make War Maps, Charts, Instruments Visible

COMPLEX maps and ocean navigation charts which can be read in total darkness and military control panels

lighted by invisible rays are now practical for war use through the development of a new group of ultra-violet (black light) sources, according to E. W. Beggs, Westinghouse lighting engineer.

All of the new fluorescent type of black-light devices, ranging from a walnut-sized bulb to a four-foot glass tube, use a newly discovered chemical coating which transforms short wave ultra-violet into near ultra-violet or black light. "Black light is fast becoming an effective war weapon for the nation's fighting forces," Mr Beggs says "Already it is making it possible for American pilots to illuminate fluorescent glowing instrument dials in the darkness without glare which would impair the pilot's ability to see out into night Even the feeble glow of the instrument panel can be dimmed or instantly extinguished at the turn of a switch"

Trail-blazing with fluorescent powders or paints is another one of the important new possible uses for black light, the engineer said By this method, markings left on trees, stones and bushes remain invisible until picked out in the darkness by ultra-violet spotlights

Maps which must be read under blackout conditions either on land or sea can actually be made to light up in the dark in several different colors for different types of information, Mr Beggs explained, in describing the most effective light sources required to activate fluorescent and phosphorescent materials Charts coated with phosphorescent chemicals act like storage batteries of light, absorbing a quantity of illumination in less than a minute and then releasing it in the dark over a period of several hours

"Both fluorescent materials, which light up only while irradiated by invisible ultra-violet, and phosphorescent coatings will have unlimited applications in civilian as well as military activities New and efficient black light lamps ranging up to four feet in length and resembling fluorescent lamps in appearance have been developed for practical use by applying a chemical coating to the glass walls of the tube," the Westinghouse engineer pointed out.

"Such units are now ready for the production aisles of war plants, the control rooms of power stations and ships and other places where complete blackout might cause dangerous confusion. The black-light lamps would light up fluorescent paint or machinery, power switches, doors and stairways and even create paths of soft illumination across the floor. The same effect can be attained without ultra-violet by using regular lighting and phosphorescent material, although this illumination is not controllable and is limited to a definite period of time," Mr Beggs explained

The most effective light sources for charging up phosphor chemicals as well as fluorescent coatings are mercury vapor and fluorescent lamps. Mr Beggs' research has revealed, although ordinary incandescent lamps and argon glow bulbs are also used Black-light is obtained from these sources by using either a purple filter or chemical coating to sift out visible light Phosphorescent paints charged up with mercury vapor or fluorescent lamps have high initial brightness

HOME DEHYDRATION

Offers New Possibilities For Food Preservation

INTEREST in the dehydration method of preserving fruits and vegetables in the home has been greatly stimulated by the prospect of a long war When fruits and vegetables are dehydrated, their bulk is greatly reduced

and a far larger quantity may be preserved per jar. Then, too, dehydrated products can be preserved quite satisfactorily in other types of containers than the conventional "fruit jars." Cel-

The dehydrating trays

lophane-lined paper bags or old tin coffee cans which may be available offer adequate protection.

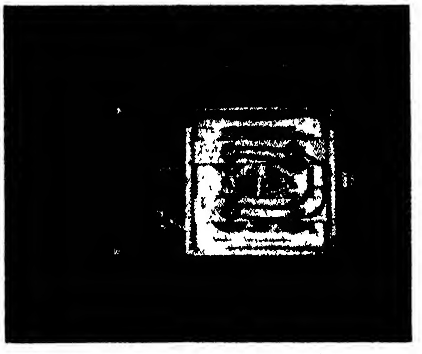
Working with General Electric engineer Howard Haynes, Drs. Donald Comin and Alvin C. Wolfe, of the Ohio Agricultural Experimental Station, have developed a new infra-red dryer that cuts drying time almost in half and in so doing produces a much more acceptable product. When drying time is shortened, these workers state, the taste quality of the dehydrated product more closely approximates that of the fresh fruit or vegetable and its nutritive value is quite likely to be higher. However, there is a limit to the rate at which moisture can be effectively removed in the drying process If it's done too rapidly, the outside of the product dries faster than the center, hardens, and thus materially retards dehydration.

In the cabinet of the new dryer are four drying trays placed one below the other. Above the top tray there are four 240-watt reflector drying lamps. The top tray is heated by the radiant energy from the lamps, the lower three trays by warm air circulation. To maintain uniformity of product, tray positions are changed every 15 or 20 minutes, the top tray going to the bottom, the others moving up one notch. A small household-type electric fan is used to further induce rapid drying; an opening at the top of the cabinet permits the moist air to escape. The relative humidity inside is kept below 65 and temperatures of 140 to 150 degrees are maintained.

Such a dryer is simple and inexpensive to construct. The cabinet may be built from any good insulating material such as half-inch Celotex. It can be conveniently placed on a kitchen table and plugged in to the nearest electrical outlet.

Another home-type dehydrator has been constructed by Orrin Hale of Seattle, publisher of *Northwest Gardens and Homes* magazine. Hale's dehydrator is built of four plywood panels forming the walls and door. These were reinforced at the edges by pine boards. Before staining, the designer gave the entire exterior of the cabinet two coats of Rez, synthetic resin sealer, which penetrated the pores of the plywood to prevent warping, the bugbear of such wooden cabinets, because they contain ideal ingredients for such a condition—large amounts of moisture and heat.

Heat is furnished by a large-size electric element in the bottom of the cabinet, controlled by a thermostat.



Looking down on home dehydrator

An electric fan blows hot air over the contents of the dehydrator and keeps the air circulating. To allow passage of air, the trays are three inches shorter than the cabinet, and are placed alternately to the front and back for better ventilation. Trays are four inches apart, are made of pine wood frames with galvanized screen on which fruit and vegetables are laid.

• • •

MILEAGE—The 32,065 members of the National Rural Letter Carriers Association consume approximately 140,000 gallons of gasoline every day in covering 1,400,000 miles. Frequent stopping and starting accounts for the low gas mileage.

• • •

FULGURITES

Fallen Wire Produces Petrified Replica of Arc

LIGHTNING recently struck a power line near Wooster, Ohio, and the broken wire carrying 22,000 volts fell to the ground. Along 45 feet of the wire as it lay on the ground the brilliant bluish white flames of the electric arc played continually, flaring up more brightly with every lightning flash which produced powerful electric surges in the wire in addition to its own current.

After the storm, long masses of glassy solidified molten sand and rock were found along the ground where the wire had lain. They were shaped like a tree trunk with short side branches. Where the arc was fiercest the trunk was four inches in diameter and the branches more than an inch in diameter.

This unusual phenomenon was reported by Karl Ver Steeg, of the College of Wooster, in *Science*.

Lightning, when it strikes in dessert sand or on a beach, often leaves a fused and petrified replica of itself. These fulgurites are sometimes several feet in length, but seldom more than two inches in diameter. The one produced by the broken wire and the storm is therefore a record breaker, doubtless due to the fact that the arcing continued for nearly three hours, while a stroke of lightning lasts but a small fraction of a second.

Fulgurites, a few inches long, have also been produced in the laboratory by causing artificial lightning to strike into a bucket of sand, as has been described in these pages in the past.

SEALING LIQUID

Protects Concrete, Wood, Against Oil Infiltration

WHEN several coats of a new liquid material have been applied on a wood or concrete surface, that surface is protected against attack by oil or grease This new sealing liquid, known as Carbo-Non-Solv, dries in two or three hours and is available in several colors It is claimed to be inert to attack by petroleum products, manufactured solvents, organic and inorganic oils, and fatty acids

RUST

Films Being Studied by Special Balance

ARMED with a new laboratory weapon, scientists are on the trail of an invisible saboteur that attacks machines and practically all metals, in peacetime as well as in war. This enemy is air, whose atoms of oxygen are constantly eating away metal surfaces. Each year these atoms cause more than $200,000,000 damage to bridges, steel buildings, and machine parts—the result of tarnish, rust, and corrosion.

To find out how oxygen combines with metals, and how fast, Dr. Earl A. Gulbransen, of the Westinghouse Research Laboratories, is actually weighing oxide films, or rust, with a tiny weighing machine so sensitive it measures billionths of an ounce.

"One thing we want to know in particular," the research chemist explains, "is just exactly what makes stainless

steel stainless. If we can uncover this secret, we may be able to find some simple way to give ordinary steel and other metals the same protection against oxygen in the air."

Dr. Gulbransen devised the special balance, and sealed it in a glass tube to take measurements on pieces of metals half the size of razor blades. Movements of the balance's pointer, so minute they can be observed only through a microscope, reveal the weight added to a tiny sample of steel by a single layer of invading oxygen atoms. One layer of atoms is about 10 billionths of an inch thick. It tips the scales at 15 billionths of an ounce.

"Our job of fighting rust is difficult," Dr. Gulbransen continues, "because we are combatting a process of nature. In extracting metals from their ores, we drive out the oxygen and other undesirable substances. Once they are purified, we try to keep oxygen from recombining with them. Tarnish, corrosion, and rust are evidence that metals don't like to be alone—would rather reunite with their former allies and slip back into the crude ores, or oxides, which are the most stable forms for them to exist in."

After the metal sample is placed on the balance, neither it nor the balance can be touched by the chemist during the experiment. The tube in which the balance is mounted is sealed and the air is removed by two vacuum pumps.

"Then the sample of steel must be cleaned," says Dr. Gulbransen, "although it was polished and washed three times in alcohol before it was placed in the tube But even the brief contact with air while putting it in the tube was enough for the formation of several layers of oxide which must be removed.

"This final cleaning is done with hydrogen. A small amount of the gas is piped into the tube from a pressure tank. The hydrogen combines with the oxygen on the surface of the sample to form free water vapor, which can then be pumped out of the tube.

"The apparatus is then ready for the start of an experiment. A small amount of oxygen is admitted to the tube from another tank. The sample gets heavier, as the oxygen combines with the surface layers of the steel, swiftly at first and then slowly. Movement of the balance beam is watched through the microscope, and the changes in weight are recorded every few minutes."

The chemist can make his experiments at any temperature from 332 degrees above zero down to 292 degrees below. "Experiments at many temperatures are important," Dr. Gulbransen points out, "because air affects metals differently at different temperatures. Stainless steel, for example, does not remain stainless above 1000 degrees, Fahrenheit"

TUBE PACKING

Redesigned to Save Materials and Space

A NEW principle of packing radio tubes which, if utilized by the tube industry, will result in shipping space, material, handling and warehousing savings, has been developed by the manufacturers of RCA radio tubes By adopting the new method, RCA alone is saving some 120 tons of packing material a year, and is able to ship approximately twice as many tubes in a boxcar or truck. To extend the value of the new packing principle more quickly, RCA has granted patent rights to the new type cartons to other tube manufacturers. In addition, other tube manufacturers have been shown factory routines that have been developed to make best use of the new process

The new packing ideas were developed by Charles I. Elliott, a 27-year-old packing engineer who attacked the problem by consigning all existing packing containers to the scrapheap Then he set about designing new type containers which would use the least possible amount of cardboard, now needed in the war effort and therefore strategically important, and that would make possible more efficient factory handling.

Mr. Elliott found that existing packing methods required the use of 210 separate pieces of packing material per 1000 tubes. Improvised handling methods were used in the factory where tubes travel from one assembly opera-

tion to another. A packing box of 22 parts, some of them no longer obtainable, was used to store and ship glass tubes.

When he had finished re-designing packing cases, Mr. Elliott found that he had reduced the 210 pieces of packing per 1000 tubes to 24 pieces. He discovered that a single one-piece, tray-like container, planned to hold the tubes safe within shipping cases, could also be used to save time in the various steps of the actual manufacturing processes themselves.

Standardization of tube packages is vitally important in wartime for many reasons. Spare radio tubes can be made to fit into spaces designed for them by the builders of planes, tanks, mobile units, ships and other fighting equipment, and the tube packages will fit the spaces, no matter from which factory they originated. This is a vital consideration with United States fighting equipment in action in many parts of the world.

In handling receiving tubes alone, savings of 30 percent in material were found to have been achieved by the new methods. Factory handling efficiency has been stepped up 20 percent, loss by breakage has been materially reduced, as has the need for storage space. It is now possible to pack 647,500 tubes of a given type into a single boxcar, an increase of nearly 100 percent in capacity

BETTER CONCRETE

Made Possible By New Form Lining

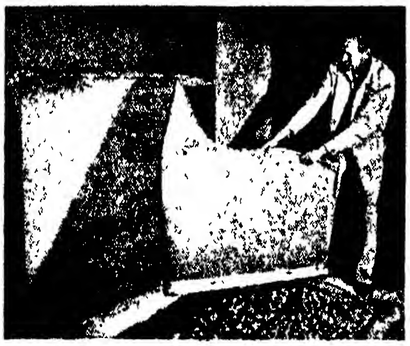
A NEW product which makes concrete several times more resistant to weather and abrasion in dams, fortifications, and construction projects of all types was announced recently by Dr. W. A. Gibbons, Director of Development, United States Rubber Company. The product is an absorptive lining for forms in which concrete is poured and is known as Hydron. By removing water and air bubbles from the surface of concrete, Hydron produces a concrete that will last longer and will have a smoother and more pleasing finish without brushing or scraping.

In one test, samples of concrete were held within two inches of an air blast delivering sharp steel grit at twenty pounds air pressure, Dr. Gibbons stated With concrete cast against ordinary wood forms the blast dug a hole one quarter inch deep in one minute. With concrete cast against Hydron the particles bounced off the case-hardened surface leaving a barely perceptible mark.

In weathering tests where samples

were repeatedly frozen and thawed, samples of concrete cast against Hydron withstood four times as many cycles as samples cast against wood

Hydron form linings consist of an absorptive material faced with a fabric and are easily applied to the concrete forms by stapling. After the concrete



Absorptive lining improves concrete

has been cast the forms are removed and the fabric is easily peeled from the concrete, leaving a smooth surface that needs no brushing, scraping, or other refinishing operation

OIL EXPLORATION

Methods Adopted for War Purposes

SOUND ranging to locate enemy artillery, listening devices to warn of the approach of aircraft and submarines, depth-sounding to determine the position of underwater objects, demolitions of land and sea mines by radio or acoustical impulses, position finding and navigating, terrain clearance determination for planes—these are only a few of the war-time applications of the science which has been so successful in finding oil fields.

Oil men, accustomed to think of geophysics as a specialized branch of oil exploration only, may be astonished to learn that this many-faceted science has dozens of uses in war.

Geophysics to the oil man is the science of mapping the dips and curves of geological formations many thousands of feet underground by the reflection or refraction of echoes from man-made earthquakes, by magnetic readings, electrical well logging, and many other means. Actually, the science of geophysics is one of the broadest, and concerns all of the physical phenomena in, and the transmission of energy through, the earth, the water and the air.

Meteorology is a branch of geophysics. So is radio. Both have their manifold added values in war time. But even the special tools of the exploration geophysicist, who in peace time searches out oil fields, assume extra importance in war.

MISCELLANY

Seismic (earthquake) phenomena are used to make foundation tests and locate construction materials for land fortifications, shelters, gun emplacements, harbor installations, and air bases, highways, railroads, bridges, canals, and tunnels Instruments measuring magnetic phenomena regularly are sent out over artillery practice ranges to determine the location of buried shells and munition dumps.

Oil and other mineral resources also take on augmented value in a national emergency, and accelerate the long-time application of geophysical exploration methods in the search for them. Even water supply and control can be aided by electrical, seismic, and well-logging methods to find water-bearing strata, make contamination surveys, test water wells, and make surveys for irrigation, drainage, flood control, and power projects.

Strategic and critical minerals such as aluminum, antimony, chrome, manganese, mercury, nickel, tin, and tungsten also can be sometimes located by geophysical methods, but exploration is much more difficult as a rule than in searching for potential oil bearing structures.

CONDUIT

Has Plastic Covering to Replace Rubber

For use in planes, tanks, and boats to protect electric wiring from gasoline and oil, there has been developed a plastic-covered metal conduit which not only is replacing rubber for such service but is adding an advantage of weight reduction.

The plastic skin over the flexible metal conduit in Amerflex, as the new product is called, protects not only the conduit itself, but also the wires inside against wear, abrasion, heat, and most solvents.

This new plastic-covered conduit is available in types which do not become brittle at sub-zero temperatures and which have high dielectric and high tensile strengths.

TRANSPARENT CLOCK

Has Glass Dial, Hands Appear to Float

The hands of the clock shown in one of our illustrations seem to float mysteriously in mid-air; their means of support is not apparent. The hands are mounted on two separate glass disks framed in metal rings, on the outer edges of which are teeth that engage with rotating gears hidden within the base of the clock. In front

of and behind the rotating glass disks are two other glass circles, the front one of which carries the hour graduations.

Clocks of this sort, made by Etalage Reclame Corporation, can be used as date reminders, by placing a suitably marked white card against the back,

As through a clock, clearly

or as timing devices in conjunction with photoelectric cells For the latter purpose, parts of the rotating glass disks can be blacked out as necessary to achieve the timing effect desired

• • •

WOODPECKERS—Fence posts treated with zinc chloride not only outlast untreated posts from three to ten times, protecting them from premature decay and termite attack, but seem to discourage woodpeckers as well. In recent experiments at Clemson College, South Carolina, several untreated posts showed considerable damage by woodpeckers, while treated posts did not.

• • •

BLACK COSMETIC

With Good Adhesion, For Commandos

Activities of Commando troops during night raids have prompted a British trade journal to suggest that the cosmetic industry might find a new outlet for its products through the development of a black face cream for use by these troops.

Such a cream, it is pointed out, should be easily applied and non-irritating It must be capable of application to the eyelids without harmful effects, and must stay on the skin in the presence of excessive perspiration

INSECT PESTS

Do Damage Running Into Billions

Man-made barriers are no barriers to insects and political boundary lines are easily crossed by crop pests, Dr. P. N. Annand, Chief of the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, said in an address prepared for the Second Inter-American Conference of Agriculture recently held in Mexico City. Because of this fact, he said, pests native to one country have often become serious problems in widely separated nations

Dr. Annand cited the series of insects introduced from abroad to the countries of the Western Hemisphere. A coordinated effort can do much to control these pests, he said, mentioning the cotton leaf worm which lives continuously in the American tropics and annually moves northward and southward into the temperate zones to seriously damage cotton

He also commented on the rapid developments in the co-operation between the Americas and commended the co-operation between the United States and Mexico as exemplified by the establishment of a laboratory in Mexico City to study fruitflies Government co-operation between Mexico and this country on the control of Pink Boll-worm started in 1927 and has continued and grown to the present date

Dr Annand pointed out that there are probably more than six million kinds of insects in the world, and 13 of these in five or more American Republics annually cost the people over $6,000,000 This is but a fraction of the total cost of insects, as in the United States alone insect damage and control costs over $2,000,000,000 annually International surveys in locating important pests would be of great value, he said

Dr Annand expressed the hope that the Conference in Mexico City might be the forerunner of a series of Pan-American conferences that would do much to solve the common problems of all American entomologists.

HIGHWAY RULES

Safety Depends on Proper Use of the Eyes

Because more than 90 percent of the judgments and actions of automobile drivers are guided by their eyes, the Better Vision Institute sets down the following 10 rules for highway safety:

1. Keep the windshield clean. A dirty windshield will cut down vision 50 per cent, or more.
2. Keep your eyes on the road. A car traveling 40 miles an hour goes nearly 60 feet in a second.
3. Wear glasses if necessary. If your eyes were good 20 years ago when you first took out a driver's license, don't take it for granted that

they are as sharp as ever. You wouldn't run a car for years without a tune-up, or checking up on the brakes.

4. If you have driven a long distance and are tired, don't take a drink of alcoholic liquor to "brace you up" to finish the trip. When you are tired, liquor may quickly make you wobbly-eyed and blunt your sight.

5. Don't drive fast at night after leaving a brightly lighted room. It takes the eyes 10 or 15 minutes to become accustomed to night driving

6. Dim your headlights at night when passing another car, and drive slowly after passing, for your car travels a considerable distance while your eyes are recovering from the glare of headlights

7 If you have eyes that see well only at 30 miles an hour, don't drive faster Know your visual capacities

8. There are more accidents during twilight than other periods of the day For most eyes seeing conditions are difficult during twilight and extra caution should be exercised

9 Know your own eyesight limitations If you have a dominant right eye that does most of your seeing, the left mudguard may easily be sideswiped If you have poor side vision, which is not uncommon, you may not see a car approaching an intersection before it is upon you

10. If you are blinded by headlights in night driving, don't wear sunglasses to cut down the glare, for they also reduce your vision and may make you almost as "blind at a bat"

• • •

COLORS—Military flares, rockets, tracer bullets, and so on, owe their bright crimson color to strontium which comes from celestite, mined in the United States and to some extent in Mexico.

• • •

TEXTILE OUTPUT

Sets New Record, Will Continue to Increase

THE cotton textile industry of this country produced in 1941 more than 10½ billion linear yards of cotton fabrics, surpassing all previous records, according to a survey made by WPB and OPA to obtain data for planning the Government's war textile program.

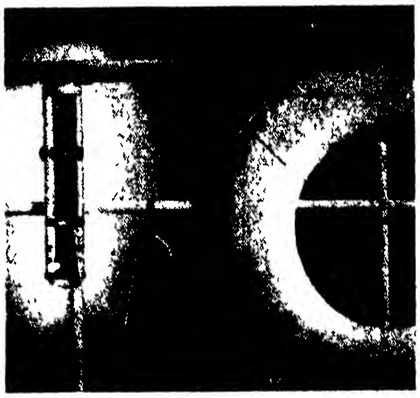
Even though the 1941 production represented a 25 percent increase over 1939 production, 1942 production will be even larger than that of 1941. WPB found it necessary, in view of steadily increasing military and civilian requirements, to plan for an estimated 12 billion linear yard output in 1942.

The reason for increasing military requirements is, of course, the steadily increasing size of our armed forces. The reason for increasing civilian requirements is the fact that cotton textiles are being called on to replace in civilian products the silk, nylon, and wool fabrics now being diverted to the armed services, and the further fact that a substantial part of textile production is being diverted to the manufacture of bagging and twine which were formerly supplied by burlap and imported cordage fibers

WATER LIGHT

Of New Type, Contributes to Life-Saving at Sea

ADDED protection for crews of coast guard and merchant marine vessels involved in submarine attacks is afforded by a new plastic-housed electric



It lights when cast adrift

water light attached to life preservers and life rafts Upon hitting the water, a weighted base turns the light upright, automatically illuminating it The light will burn continually for 10 hours or longer, indicating to rescue craft the position of drifting seamen

Use of "Lucite" methyl methacrylate plastic has reduced the weight to one-fifth that of the usual water light. The housing weighs about 19 ounces, the entire light just over three pounds.

The tough plastic is water resistant, protecting the lamp and battery.

SPATTER PROOFING

Used in Arc Welding to Speed Up Work

WELDING spatter is prevented from adhering to metal surfaces if those surfaces are coated with a new material developed by Acme White Lead and Color Company. This material, which can be applied by brush, spray, or by wiping, conducts electricity, and, it is claimed, helps to prevent the arc from breaking. After welding is finished, the surface coating is removed by wiping, leaving the welded part ready for paint or other processes.

Industrial Growth

New Products and Processes That Reflect Applications of Research to Industrial Production

SURFACE FLAWS

Disclosed by New Liquid and Ultra-Violet Light

FOR the detection of surface defects in non-magnetic materials, a new fluorescent liquid has been developed. This liquid, which is used to cover the surface to be examined, glows under the influence of ultra-violet light to indicate the position and character of defects extending inward from the surface. The liquid, developed by Magnaflux Corporation, discloses flaws that are relatively deep compared with their width, and the indication can be interpreted as to type and extent Scratches and minor surface irregularities are not shown.

PROTECTION

For Polished Surfaces Afforded by Removable Film

APPLIED by spray, brush, dip, or roller, a new material is available for protecting polished metal surfaces and ceramic parts. The material, produced by Ault and Wiborg Corporation, dries to a flexible, transparent film in from six to eight minutes at 200 degrees, Fahrenheit. Thus, coated parts can be inspected yet the film can easily be removed when necessary by peeling or blowing off with an air valve after one corner has been loosened The removed material can be reused after it is again reduced to liquid form.

HEAT TREATING

Copper Plating is Restricted, is Easily Removed

IN the heat treating of steel parts it is often desired to harden local areas while other areas remain soft This selective hardening is accurately controlled by copper plating and thus protecting those parts which are to remain soft.

To expedite such work the Michigan Chrome & Chemical Company has recently announced a lacquer which is to be applied to those parts of a steel piece that are to be hardened. Following the plating operation, during which no copper is deposited on the lacquered areas, the lacquer is removed and the heat treatment carried through Thus it becomes unnecessary, as is done when the lacquer is not used, to grind the copper plate from areas that are to be hardened.

Another material, developed by Sulphur Products Company, is used in the same type of work. This chemical is designed for rapid removal of copper plating from the masked parts after the hardening operation has been completed The plated part is merely immersed in a water solution of the chemical and then dipped into a solution of sodium cyanide The copper plating, it is stated, is thus removed without injury to the plate.

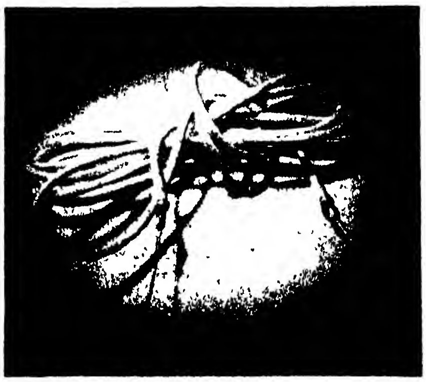
FLEXIBLE HEAT

Provided by Glass-Insulated Units

AVAILABLE in any length, by the inch, foot, or yard, a low-power flexible heating element now finds many uses particularly in limited space Known as the Glasohm, and also used as a flexible power resistor, this is a product of Clarostat Mfg Co, Inc

In the Glasohm construction the resistance wire is wound on a fiber-glass core and is protected by a fiber-glass braided covering The unit can be readily bent and compacted to fit snugly about parts to be heated, or jammed into tight spots, in either case providing an efficient heating means Wattage ratings are from 1 to 4 watts per body inch depending on the application, and operating temperatures are up to 750° Fahrenheit

Glasohm heating elements are now



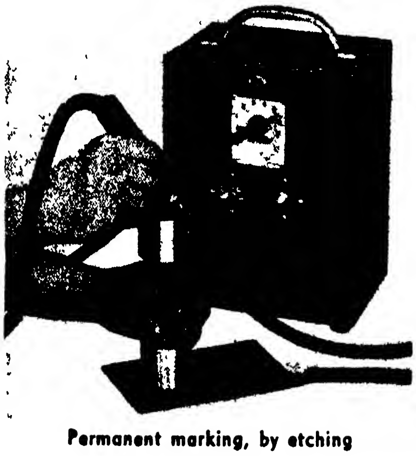
Heat by the inch, foot, or yard

found in electric soldering irons, electric pencils, curling irons, water immersion heaters, and other low-power appliances. Also in temperature-control ovens for oscillating radio crystals, the heating of aviation and marine instruments, localized heat for chemical apparatus and laboratory equipment, and similar applications.

METAL ETCHER

Has Wide Heat Range For Various Uses

For permanently marking tools, parts, and so on, made of iron, steel, or their alloys, the new electric etcher shown



Permanent marking, by etching

in one of our illustrations has been developed by the Ideal Commutator Dresser Company.

This etcher, provided with 14 etching heats, is equipped with a work plate and a ground clamp Small tools and parts are etched by placing them on the work plate; the ground clamp is used for making connection to large heavy parts and castings

GANTRY CRANE

Is Equipped With Swivel Casters

A crane that can be used on any firm, level floor, which is not restricted by tracks or overhead runways, and which can be moved from one location to another, has recently been made available by the Service Caster & Truck Company. This crane, shown in one of our illustrations, is available in sizes from 500 pounds to 20,000 pounds, each of which is equipped with eight casters furnished with floor locks Such a crane can be built in any reasonable height and may be used as a truck after lifting the load off the floor. The flexibility of operation provided by the casters makes the cranes adaptable to many shop and industrial purposes

BABBITT

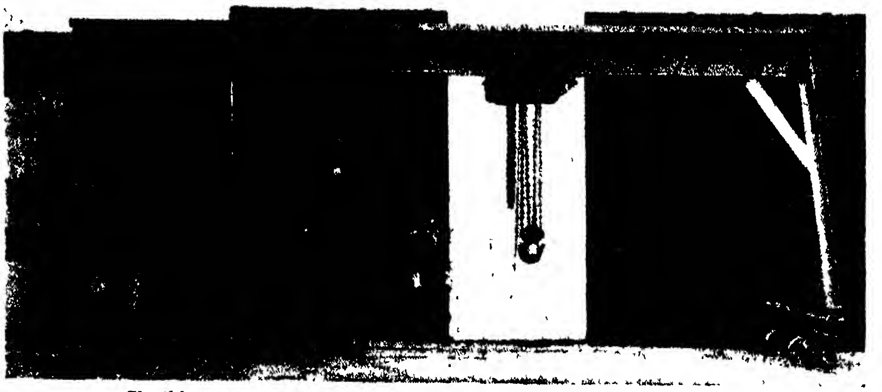
Bearings Have New Low Tin Content

A new low-tin babbitt has been developed for general application under many normal operating conditions and in cases where fitting and lubrication will be carefully watched This bearing material, known as Rex, and manufactured by the National Bearing Metals Corporation, has a compressive strength of 17,500 pounds per square inch and pours at 625 to 675 degrees, Fahrenheit.

FLOOR PROBLEMS

Solved by Use of Oil-Absorbing Material

Oily surfaces, always a hazard in shops, can be completely eliminated by the use of a newly developed material which replaces the more conventional sawdust and sand This new material, known as "Quick-Sil," is absolutely fire proof and will not ignite or sustain combustion "Quik-Sil" is used by spreading it on wet and oily surfaces, where it absorbs the oil and completely dries up the floor If the oily surface has become caked, a solvent is first applied and then the "Quik-Sil" spread over to absorb the solvent and oil at the same time



Flexible operation is the keynote of this new crane for industrial use

GLUE EXTENDER

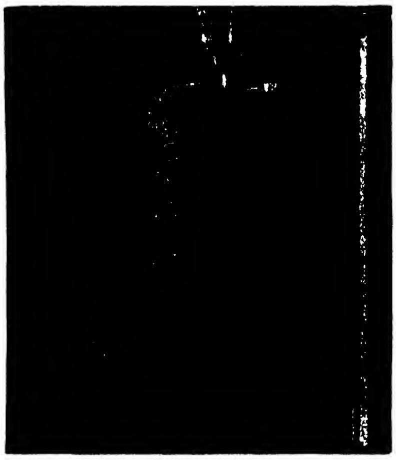
Mineral Gives Advantages To Adhesives

ADDED to glue in proportions up to as high as 25 percent, a new pulverized mineral material known as Micromite Glue Extender, increases the body of the adhesive and allows it to flow freely. It is supplied in 50 pound packages by the manufacturer, the Tamms Silica Company.

SPINDLE

Covered With Steel Wool, Removes Burrs

STEEL wool, an abrasive material ordinarily considered only for use in hand operations, can now be used on a spindle for high-speed production operations in the removal of burrs from non-ferrous metals. Such work is made possible by the use of "ribbon" type steel wool which is wrapped around a small shaft and the completed spindle mounted in a chuck. These spindles, made by the American Steel Wool Manufacturing Company, Inc., make it possible, it is claimed, to clear burrs from three sides and two edges in one operation. Also, when the spindle is in use, it is said to make no permanent grooves



Powered burr remover

RESISTANT PAINT

Used in Presence of Acids, Alkalies, Salts

DESIGNED to replace chlorinated rubber paints, now unavailable because of the rubber shortage, a new surface coating is obtainable which shows outstanding resistance toward acids, alkalies, oxidizing agents, and salts. This new paint, for use in chemical industries, pickling plants, textile mills, and so on, is composed of a combination of domestic waxes. Known as Rust-Ecter 66, this coating dries as rapidly as the rubber paint which it replaces —that is, in less than one hour.

The one point in which this new paint is inferior to rubber paints is in oil resistance; oils and greases will dissolve it rapidly

PLASTIC MALLET

Does Not Throw Sparks, Resists Wear

THE HEAD of a new non-metallic mallet is made of a canvas-base laminated phenolic plastic material which is secured to a hickory handle by a laminated Bakelite wedge. Such a mallet head will not throw sparks under any conditions of use and hence can safely be employed in munition and shell-loading plants

It is claimed that this mallet, made by the Penn Fibre & Specialty Company, resists wear and does not deteriorate with age The face can easily be resurfaced on a grinding wheel.

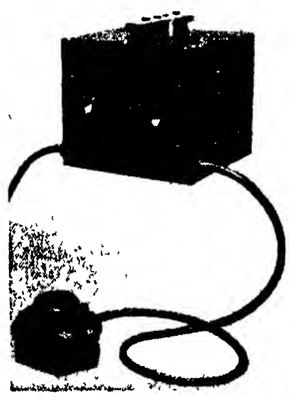
SOLDERING

Special Transformer Equipment Is Used With a Jig

ONE of the specific applications of the soldering equipment shown in an accompanying photograph is to a multiple-leaf condenser assembly which is set up in a specially designed jig When the current is applied to the leaves through the jig, the complete soldering operation is finished in 1½ to 2 seconds, under control by a foot switch By ordinary methods the leaves were soldered individually.

Similar complicated soldering jobs can be accomplished with this transformer setup, which is furnished with a ten-step heating adjustment, by correct design of the jig for the work to be handled. The American Car and Foundry Company, manufacturers of the equipment, also co-operate on problems concerning jigs to be used for various purposes.

Complicated industrial soldering jobs can readily be accomplished with this new transformer



The Thunderbolt in Action

Why This Fine Plane is Rightly Called the Fastest and Most Powerful High-Altitude Fighter of the Day

ALEXANDER KLEMIN
Aviation Editor, Scientific American.
Research Professor, Daniel Guggenheim School of Aeronautics, New York University

WE HAVE only the highest commendation for the report on our combat airplanes which was recently issued by the Office of War Information. Since the time when the subject of the quality of our fighting aircraft became controversial, a number of government announcements or reports have appeared, but none have been so objective, so accurate, and so dispassionate as the report of O W.I. under the capable leadership of Elmer Davis.

The Republic P-47 Thunderbolt comes under the head of supporting evidence Powered by a Pratt & Whitney 2000-horsepower engine, equipped with a multi-stage turbo-supercharger, heavily armed and armored, the Thunderbolt has a good claim to be called the fastest and most powerful high-altitude fighter of the day. It is being put into production not only at the plant of Republic but also at the plant of one of our other important airplane manufacturers.

The photograph below shows the P-47 going through its paces for the benefit of a cameraman We note the all-plastics sliding canopy which gives the pilot excellent vision, the neat engine cowl which gives the impression that engine, cowl, and fuselage blend inperceptibly into one another; the smooth, well filleted wing; the ominous number of machine gun bores protruding from the leading edge of the wing The design is attributed to Alexander Kartveli, a noted Georgian engineer.

MATERIALS

Airplane Parts are Fertile Field for Substitutions

THE USE of plywood in airplane construction as a substitute for aluminum alloys has often been discussed, but this is not the only example of material substitution L D Bonhain, of Lockheed Aircraft Corporation, in a paper before the Society of Automotive Engineers, describes wide and successful use of "non critical" materials in airframe construction and some of these substitutions have proved so satisfactory that they are likely to remain after the end of the war.

Alloying elements such as nickel, chromium, molybdenum, vanadium, and manganese are scarce and difficult to obtain. Hence, in many sheet metal parts and in tubing, alloy sheets have been replaced by low carbon steel Stainless, corrosion- or heat-resistant steel has been displaced even in such essential elements as firewalls, exhaust-shrouds, and ammunition boxes Such substitutions may mean added

Supporting evidence of the accuracy of the recent O.W.I. report on the quality of our fighting airplanes: the Thunderbolt, in many ways the best of our military planes

weight but the added weight is fully justified except for important combat airplanes.

While alloy sheets are being replaced by low carbon steels, the conservation of aluminum is being accomplished by the use of plywood, plastics, wood, and magnesium A great permanent use of these latter materials may be expected. This is particularly true of magnesium, for whose production facilities have been enormously increased. In finishing materials, naphtha and alcohols have displaced scarcer materials as thinners Rubber has been eliminated by the use of synthetic rubber, felt, and bound hair American industry, metallurgical and chemical, has risen to the occasion, and airplane designers have co-operated magnificently. We can do just as much as the Germans in the matter of "Ersatz," though we brag less about it.—*A. K*

SOUND-PROOFING

Needed in Engine Testing Laboratories

WITH enormously powerful engines and their necessary propellers it is quite a problem to reduce the resulting noise. Engine laboratories must therefore be enclosed in massive buildings which, by their bulk, prevent noise transmission. Also, both inlets and outlets to the test cell must embody sound-absorbing devices

In one engine testing laboratory the test cell is equipped with sound-absorbing baffles of Fiberglas pads installed in the inlet stack Vertical stacks are about 40 feet high with a 20-foot square opening Similar Fiberglas wool stacks are provided at the outlet.

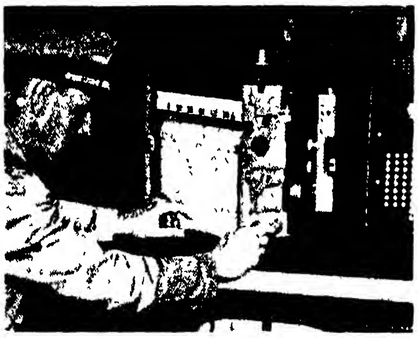
Fiberglas thermal insulating wool is glass in soft, flexible, fiber form. It seems to meet all the practical requirements of this special use Among these are: high noise reduction or sound absorption coefficients; ability to stand up under wind speeds of 100 miles per hour; resistance to gasoline and oil fumes; fire proof, particles of acoustical materials, which might injure motors or test devices, cannot get into the air stream; chemical inertness; rapid draining and drying properties. — *A. K.*

Quiet, please. Engines testing

FLIGHT RECORDER

Takes Over Some Flight Engineer's Duties

THE heroism of the test pilot—how frequently he risks his life, how he suffers temporary blindness when coming out of a steep dive, and the like—has been well recorded by the press.



Test pilot's flight recorder

Flight test engineers undergo only some of these risks, but they have arduous duties which involve, among other things, taking by hand notes of engine and plane performance, and of speed, pressure, and temperature in many parts of the engine. In fact, with the complexity of the modern airplane, it has become almost impossible to take the necessary records frequently enough in a power dive or a steep climb.

To meet this situation, the Brown Instrument Company has developed a new electronic instrument, a portable "flight-recorder" which was specifically designed for the Douglas B19, the world's largest plane, and is an adaptation of a new type of self-balancing electronic potentiometer. When in service on the B19 it automatically prints on paper the temperatures of all 72 cylinders of the four motors, the temperature of the carburetor, exhaust, and oil lines, and also the pressure distribution on wing-struts, bulkheads, and tail surfaces. Douglas Aircraft engineers have increased the recorder's range by the use of a selector switch, which permits readings to be taken in six groups of 24 each.

In spite of its complex service, the recorder is compact enough for use on a single seater pursuit where it is physically impossible to carry a group of test pilots.—*A. K*

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

A First Aid Index is an accordion-type folder, 6½ by 3 inches, which bears the approval of the Commander-in-Chief of the U. S. Volunteer Life Savings Corps. It covers, with illustrations, all the important points in elementary first aid. *Sylvania Electric Products Inc., 500 Fifth Avenue, New York, New York.—Five Cents.*

Keeping Livestock Healthy is the 1942 Yearbook of the United States Department of Agriculture and its 1276 pages are this year devoted entirely to the fundamentals of animal disease and insect control, also diseases and parasites of swine, goats, poultry, dogs, cats, and wild life. 98 chapters by various authorities. *Superintendent of Documents, Washington, D. C.—$1.75.*

Turret Lathes is an eight-page catalog describing and illustrating a line of lathes and their attachments and accessories. Important construction features are stressed. Request Catalog No. 67-W. *South Bend Lathe Works, South Bend Indiana.—Gratis.*

What Keeps the Wheels Turning is a 20-page illustrated booklet which tells the story of electrical power in present-day industrial operations, and the specific part which glass insulation plays in keeping this power in operation. *Owens-Corning Fiberglas Corp., 100 Nicholas Bldg., Toledo, Ohio.—Gratis.*

Wire Data Card is a 5¼ by 3 inch celluloid card on which tabulations give the composition and physical properties of certain alloy wires, as well as wire gages and a feet-per-pound conversion method. *Callite Tungsten Corporation, 542-46 39th Street, Union City, New Jersey.—Gratis.*

Handbook of Welded Steel Tubing is a loose-leaf data book which gives a summary of the physical, chemical, and metallurgical properties of welded carbon and alloyed steel tubing, together with commercial tolerance limitations and extensive engineering data. *Formed Steel Tube Institute, 1621 Euclid Avenue, Cleveland, Ohio.—$1.*

Stamping, Marking, and Numbering is an 8-page brochure which illustrates and describes more than 65 modern marking tools and machines which are adaptable to a wide range of ordnance and industrial marking. *Acromark Corporation, 390 Morrell Street, Elizabeth, New Jersey.—Gratis.*

Specifications for Productive Lighting in War Plants is a 32-page illustrated manual designed to meet the needs for up-to-date data on the use of lighting as a production tool. The lavishly illustrated text deals with problems of production, rejects, employee fatigue, accidents, and so forth. Both fluorescent and incandescent lighting are covered, and complete solutions are given for 21 lighting problems of the kind most commonly encountered. *Benjamin Electric Mfg. Co., Des Plaines, Illinois.—Gratis.*

Heat Transfer Through Metallic Walls is a 20-page illustrated bulletin which describes in detail methods of calculating the rate of heat flow through metallic walls. It dicusses conductivity of various metals under different operating conditions, and other phases of the subject. A series of charts eliminates much tedious computation. *International Nickel Company, Inc., 67 Wall Street, New York, New York.—Gratis.*

Fatigue Versus Efficiency is a 10-page illustrated multigraphed folder which describes briefly, yet completely, the causes of fatigue in industry, in the home, and in schools, carrying along through the effects of such fatigue to suggested methods of relief. *American Bottlers of Carbonated Beverages, 1128 Sixteenth Street, N. W., Washington, D. C.—Gratis.*

The Wood Preserving Industry and The Conservation of Forests is a 34-page illustrated review of the lumber, cross-tie, and wood preserving industry in the United States. It presents charts on various activities, and specific information on preservative methods. *Grant B. Shipley, Koppers Building, Pittsburgh, Pennsylvania.—Gratis.*

Rabbit Raising (Conservation Bulletin 25 of the Fish and Wildlife Service, Department of the Interior) is a 64-page booklet dealing with feeds and feeding, breeding, management, equipment, and marketing, in connection with rabbit raising for food and fur. *Superintendent of Documents, Washington, D. C.—10 cents cash.*

Glues for War is an illustrated four-page broadside detailing the uses in which wood and glue are alternating for steel in production of vital war materials. Also shown are simplified methods of glue mixing and application. *I. F. Laucks, Inc., Maritime Building, Seattle, Washington.—Gratis.*

Felters is a 12-page catalog devoted to a description of felt as an engineering material and its applications in industry. Data presented cover grades, properties, and specifications, as well as applications to vibration isolation, sealing of lubricants, sound absorption, and so on. *The Felters Company, Inc., 210 South Street, S. W., Boston, Massachusetts.—Gratis.*

Partial List of Uses of Forest Products In Subtitutions for Steel and Tin is a mimeographed report giving lists of numerous manufactured items customarily made from metals which have been and can be made from wood or wood derivatives. Publication R1289. *U. S. Forest Products Laboratory, Madison, Wisconsin.—Gratis.*

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with the names of available books, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for. Books listed in these columns may be ordered from our Book Department

A LAYMAN'S GUIDE TO NAVAL STRATEGY

By Bernard Brodie

No stuffy, pedantic book is this—instead, most readable. The author writes in a smoothly-running style which can be followed without brow-knitting. While non-technical, it follows the same general ground as a technical treatise. While it was not written as a reply to the De Severskys and the Ziffs, it does, and without the least rancor, reply to these writers to the extent that their air-mindedness is extreme, arguing for sound balance between air and sea forces (291 pages, 5½ by 8¼ inches, lightly illustrated.)—$2 60 postpaid.—*A G I*

PHYSICAL CONDITIONING

By George T. Stafford and Roy O. Duncan

Two noted physical culturists present a conditioning program primarily for use of coach and athlete, but one which will unmeasureably benefit all who religiously follow its tenets (110 pages, 6 by 9 inches, many drawings, index.)—$1 10 postpaid.—*A D R, II*

THE AMERICAN ANNUAL OF PHOTOGRAPHY

Volume 57

Here it is again—the annual standby. Comprehensive articles on many phases of photography, plus an exhibit of the year's best photographs (240 text pages, 36 advertising pages, 7¼ by 10 inches, paper covers, lavishly illustrated.)—$1 60 postpaid.—*A.P.P.*

STAR MAPS FOR BEGINNERS

By Levitt and Marshall

Set of 12 full-page, white-on-black, shamrock-shaped, month-by-month charts, with accompanying discussions, instructions for use, table of planetary locations till 1947. (33 pages, 8½ by 11 inches.)—$.50 postpaid.—*A G.I*

THE MAN BEHIND THE FLIGHT

By Assen Jordanoff

A complete course of instruction in the fundamentals of aeronautics for the men who are building our airplanes and keeping them in flight, packed down into solid straight-from-the-shoulder text. This book provides the facts that aviation students need to know about physics, mechanics, hydraulics, and electricity. Written for easy reading, yet not "written down" (276 text pages, 8 by 10 inches, lavishly illustrated with explanatory drawings, plus 90 photographs of plane types and aviation personalities.)—$3 60 postpaid.—*A.P.P*

STOWAGE

By Captain Pierre Garoche

An American adaptation of the author's original work on handling and transport of cargoes. Author is well known in maritime circles as Chief Officer of French School Ship, as shipping supervisor of all supplies from here to France before his country's fall. Covers problems of operation, loading, stowage, transportation, damage, carriage of special cargoes (437 pages, 5 by 7¼ inches, many diagrams, index of subjects and port facilities throughout the world.)—$3 60 postpaid.—*A.D R, II*

SCIENCE AND MAN

Edited by Ruth Nanda Anshen

Essays by Hrdlicka (human evolution), Compton (purpose of science), Niebuhr (religion and action); Kaempffert (science and democracy); Koffka (the psychologist); Huxley (science, natural and social); Cannon (body scientific and politic); Mumford (looking forward); Jessup (international law and totalitarian war); Jung (human behavior); Conklin (science and ethics); and a dozen others. These vary considerably in interest but not in level—that of the more intelligent, thinking fraction of the population who seek mental stimulation rather than factual enlightenment. Critical essays (494 pages, 5½ by 8½ inches, unillustrated.)—$4 10 postpaid.—*A. G. I.*

THE LONG SHIPS PASSING

By Walter Havighurst

Exhibiting a keen insight into the geographical and economic importance of the 300-year history of the Great Lakes, the author has presented a dramatic, entertaining, rapid-fire saga of the world's mightiest waterways. It is a vivid trail of progress from legendary seas, through the chants of voyageurs, the vanished fleets of sailing vessels, the immigrant boats, the post-Civil War

freighters, the building of the Soo Canal —where a laden ship passes every 20 minutes for eight unfrozen months of each year—down to the present vital parade of long ships passing from Superior to the steel mills, with their cargoes of war-winning iron ore. Excellent Americana (291 pages, 5½ by 8¼ inches, index.)—$3.10 postpaid.—*A.D.R., IV.*

HOW TO REMODEL A HOUSE

By Dalzell and Townsend

Not alone how to do it, but how to plan it. Not for architects, but for actual owners. This book gets down to brass tacks on practical details and principles; it isn't merely vague and general and doesn't merely show a lot of before-and-after pictures. (528 pages, 5½ by 8¼ inches, 318 illustrations.)—$4.85 postpaid —*A.G.I.*

FUTURE OF TELEVISION

By Orrin E. Dunlap, Jr.

Television at present represents a sleeping giant of science and commerce, which, when it finally awakens, holds promise of becoming a billion dollar industry, employing thousands of people in a multi-ringed circus that today still challenges the ingenuity of electronics research and radio engineering. In the smoothly written text of this book, Mr. Dunlap lifts the edge of the curtain and looks forward into the future. Only the next generation can prove the accuracy of his prophecies. (194 pages, 6 by 9 inches, a number of photographs.)—$2.60 postpaid.—*A.P.P.*

SEISMOLOGY

By Professor Perry Byerly

Compact volume, emphasis on succinctness. Easy chapters on elasticity and plasticity; earthquake vibrations; causes, effects and distribution of quakes. Hard chapters (calculus, physics) on seismograph; elastic waves; paths of waves and travel time curves; location of epicenters; seismograms Solid book. (256 pages, 6 by 9 inches, 58 illustrations.)—$4.75 postpaid.—*A.G.I.*

HANDS OFF!

By Major W. E. Fairbairn

By the author of "Get Tough!" this book is the woman's version of unarmed self-defense. Not a collection of parlor tricks, but sensible, sane, realistic, proved, self-protective methods with the hands as the only weapons. Excellent course for women and girls in war or peace. (41 pages, 5¼ by 8 inches. Profusely illustrated. Paper cover.)—85 cents, postpaid.

HANDWRITING ANALYSIS

By Stein and Zubin

As ordinarily practiced, graphology is a pseudo-science, frequently degenerating to the level of palmistry and astrology. But there is an empirical science of graphology made possible by the fact

that, like posture, gait, and mannerisms, handwriting is a form of behavior expressing intellectual and emotional habits This primer of graphology isn't a bit like the familiar popular treatises, because it isn't so specific (the specificity is largely gratuitous). It is a dry, statistical, basic, hard study of underlying principles, not of intuitional thrills. Authors are connected with the New York State Psychiatric Institute, and book is published by a division of the Columbia University Press. (147 pages, 5½ by 8½ inches, illustrated.)—$2 10 postpaid —*A.G.I.*

EXPERIMENTAL ELECTRONICS

By Ralph H. Muller, R. L. Garman, and M. E. Droz

SOLID is the word for this book, written to supply practical information on the characteristics and non-communication applications of electron tubes The experiments on which the text is based are clearly described and the results of each are presented in tables or graphs of original data. Written for students, radio engineers, communications experts, and the general reader who wants to dig deeply into this most modern of all sciences (330 pages, 6½ by 9 inches, a large number of drawings, completely indexed).—$4 75 postpaid —*A.P P*

PARACHUTES

By Herbert S. Zim

THOROUGH study of the timely, exciting subject of parachutes, how they are made, how used in warfare and in civilian life Development of the 'chute from early beginnings, with data on laws of gravity, other pertinent scientific principles, problems of jumps, training of fighting services, details on use in forest fire-fighting, in exploration, delivery of mail and supplies, meteorology. (252 pages, 5¼ by 8½ inches, profusely illustrated)—$2 60 postpaid.—*A. D. R., IV*

MAP READING AND AVIGATION

By Field and Stetson

BRIEF, elementary textbook for aviation students Part I drills the reader on what he should know about contour, and other maps, and their close interpretation, also on aerophotographs. Part II teaches the rudiments of celestial navigation Elementary algebra and plane geometry are prerequisites Authors are professors respectively at Princeton and M I.T. (129 pages, 8½ by 11 inches, 83 illustrations) —$2 60 postpaid—*A G.I.*

HOW TO TRAIN HUNTING DOGS

By William F. Brown

FUNDAMENTAL training of recognized breeds of hunting dogs, with history and standards of each, data on particular use, and proved system of education Author is editor of *The American Field* and is recognized in many circles as *the* authority on field trials. (228 pages, 6 by 9 inches, 217 illustrations)—$2.60 postpaid.—*A.D.R., IV*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

WHICH is the best type of tube for a reflecting telescope? Old argument, never settled, because it depends too much on personal factors. (Which is the best type—blonde, brunette or red-head?)

Alfred Bryant, 516 Egleston Avenue, Kalamazoo, Michigan, settled one of these questions, the one about the telescopes, for himself by making one telescope for each type of tube (Figure 1). From left to right these are.

Hexagonal tube (9¼" mirror, 78" f.l.)

Octagonal tube (12½" mirror, 81" f.l.)

Square tube (6" mirror, 70" f.l.—solar telescope).

Skeleton tube (7¼" mirror, 58 f.l.). But Bryant throws out the skeleton tube for city use—extraneous light makes too much trouble.

Round tube (7¼" mirror, 58" f.l.).

Round tube was all right, Bryant says, but "it is hard for the beginner to direct his tube to find objects."

Hex and octagonal are all right but hard to make.

He votes for the unromantic square type. Easy to make. Easy to direct. Doesn't need internal ribs. Easy to adjust optical parts. "I admit," he says, "the square type doesn't look so handsome, but looks do not a telescope make."

The R. A. circle on the 12½" consists of a 72" steel tape around a pulley, giving 3" spacing per hour, which is good for visibility.

Incidentally, Bryant must be industrious.

SCHMIDT camera and mounting, made by Philip Knowlton, 83 LaSalle Street, New York, New York, is shown in Figure 2. It has an 8" Pyrex mirror stopped to 7", a 3½" correcting lens and rates as $f/1.9$.

Correcting lens is a disk of Vitaglass 1/32" thick, figured flat on one side; on the other convexed, then concaved near the edge. It has an extra stop which works at $f/4$, also a 77mm haze filter. Tube is ½" five-ply plywood reinforced with 16-gage iron.

"Fussiest job," Knowlton writes, "was design of film holder." Figure 3 shows the one made. "By experience I found that the focus is so short that the back of my hand contacts the mirror while loading film.

"Plate glass would have been easier than Pyrex to grind so deep for the mirror if no machine had been available. A machine should be used—for if anyone thinks there's a lot of rub-rub-rub to a common 6" $f/8$ mirror, let him try a Schmidt by hand—mine took the spare time of 10 months. But it was not

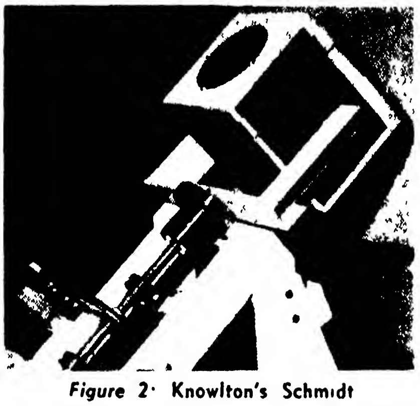
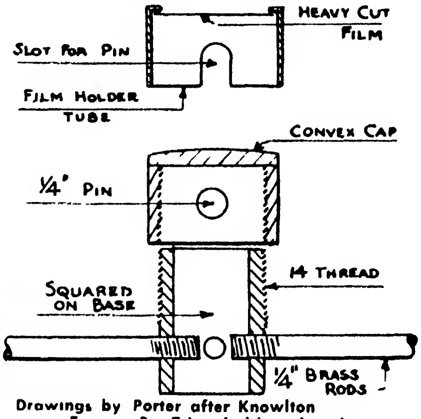


Figure 2: Knowlton's Schmidt

as difficult as at first it seemed—mainly tedious.

"The fork of the mounting is of 3" angle iron, welded and bolted to a heavy stub-shaft resting in a roller bearing. The fork is long enough to permit the camera to be pointed north. Main supports are of 2" x 4" material, each leg having an adjustment.

"The clock drive consists of a lever (Figure 4) on the polar axis shaft, its broad flat end faced with hard rubber. This bears against the knurled knob of the alarm clock. The clock may be shifted sidewise and the lever lengthened or shortened to obtain adjustment of drive speed."



Drawings by Porter after Knowlton

Figure 3: Film holder details

AS EACH new crop of amateur glass workers comes along, a few individuals discover coal tar pitch and are led to think it is something new. Following from an old letter from J. W. Fecker, Pittsburgh professional, gives answer.

"Both Lassell and Herschel used coal tar pitch and describe the use of it in some of their earlier memoirs. We have used

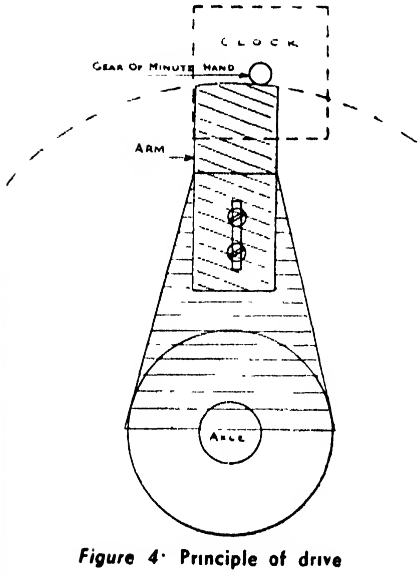


Figure 4: Principle of drive

it here in the shop ever since the business started and it is used on all large jobs.

"Coal tar pitch works very well, particularly on glass such as Pyrex and the ordinary crowns and flints. Some of the special glasses, like barium crown, fluor crown, and the extremely dense flints, do not polish so well on coal tar pitch, due to some of the oils in the tar causing

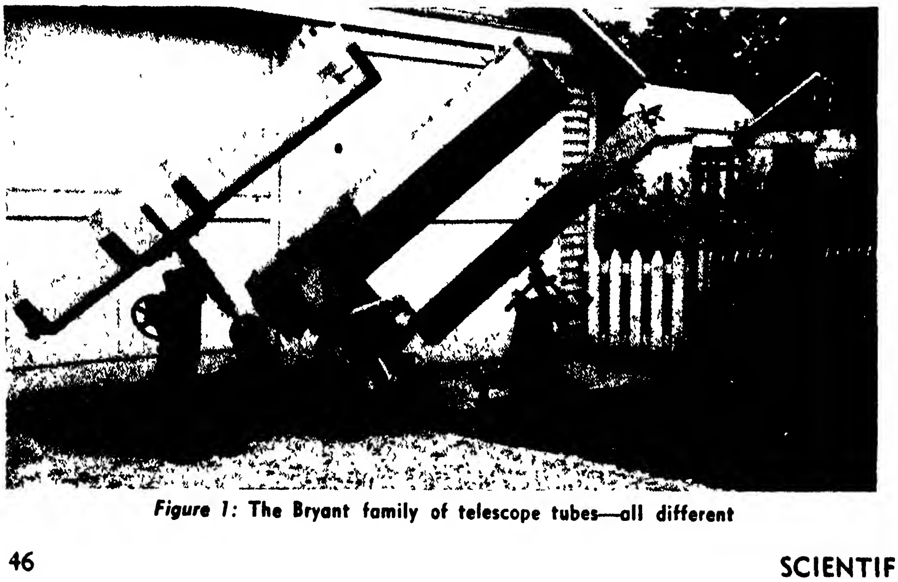


Figure 1: The Bryant family of telescope tubes—all different

a staining action on the glass. Particularly is this noticeable on the extremely dense flint.

"We generally mix the coal tar pitch with asphalt, resin, bee's wax, pine pitch, or whatever is necessary to give us the requisite body. For small lens work where the spindles run at high speed, we use quite a bit of pine tar pitch. We also temper it by boiling it for a long time to boil out the oils and make the tar harder.

"The hardness and consistency of the polisher depends to a large extent on the type of work you are doing, and no one mixture is a universal polishing agent.

"For the amateur, I presume pine tar pitch is a little better, because coal tar pitch has a tendency to soften, and give edge error."

Figure 5: Tarbell and housing

NEAT housing for a telescope is shown in Figure 5. F. D. Tarbell, Hunter Avenue and Leeds Road, Kansas City, Nebraska, is the designer and maker. He writes: "The housing itself is made of 20-gage galvanized iron braced by 1" angle iron ribs, though the one at the open end is 2". The whole housing slides on a two-by-four track set on posts. The sills of the cover are two-by-eights. The rollers are rear wheel car bearings from a junk yard. The rear pair are not placed near the end but about two thirds way back, enabling me to use a shorter track extension back of the telescope.

"The inside of the housing is painted black, and at the rear I have a tray in which I can change films for photographic work, even in full moon, without causing fogging."

ANOTHER amateur with a unique way of making a pitch lap is Robert E. Smith, D.D.S., Medico-Dental Bldg., Sacramento, California. He says he first obtains the "Pittsport Doormat," a rubber device prepared by the H. O. Canfield Co., Bridgeport, Connecticut, and used by numerous amateurs for casting tailor-made laps of pitch. One of these is shown in Figure 31, page 37, of "Amateur Telescope Making—Advanced." Usually when they come there is a web between the partitions and the user must chisel this out, but Dr. Smith leaves it in—he even asks the makers to select a mat having a good, flat web with no undulations or imperfections. He describes the job thus: "Cut the mat to fit the mirror, with its squares off-center, of course. Place mat on mirror. Wrap the customary collar around the edge, I use rubber for this. Paint the whole thing with glycerine. Pour melted pitch into all the squares,

TELESCOPTICS

making sure there is more than enough. Place the warmed tool on this and the lap is practically made. Its neat channels also run clear down to the glass as is desirable.

"Let it cool somewhat and then remove mat and collar, chamfer the lap and cold press, and there you have it. Such a lap is pretty to look at and easy to make."

Maybe just at present Japan may have something to say about making a lap that way—rubber. But that should not last forever.

PRISMS. Cyril G. Wates, 7718 Jasper Ave., Edmonton, Alberta, Canada, offers simple tests for telescope prisms for diagonals, which anyone can apply. He writes:

"There is no way of testing the flatness of prism faces except by observing the interference fringes when the prism is brought into contact with a standard flat. This note deals instead with methods of testing the correctness of the angles. The right angle between the square faces may be tested with great accuracy by the method described by Russell W. Porter on page 54, 'A.T.M.,' and improved by John M. Pierce. The prism is placed with the large face toward the observer. A white card having an accurately circular hole about 1/8" in diameter is held close to the eye. The hole appears as a black spot in the center of the prism, the spot being bisected by a line which is the edge formed by the two square faces. If these faces are at right angles, the spot will appear circular, as in A, Figure 6. If the angle is more than 90°, the spot will be drawn together as in *B*; if less than 90°, the spot will appear elongated as in *C*. The corresponding shapes of prism are shown in the lower part of the figure. This type of defect is called axial-angle error.

"Assuming that the square faces form a true right angle, there remain two ways in which the prism may be incorrect. In the first, the two acute angles, which should both be exactly 45°, may be unequal, as shown greatly exaggerated in *D*. Now, referring to *E*, imagine the prism cut by a plane surface exactly perpendicular to the face *x*, as shown by the dotted lines. In the second, the other two faces, *y* and *z*, should also be perpendicular to the same plane If they are not, the prism is actually a section of a pyramid, as shown in *F*, and this is called pyramidal, or sometimes side-angle, error.

"The two errors last described may be tested very simply by use of the principle of triple reflection. The set-up is shown in *G*. The prism is placed on a table in a dark room, with one of its square faces toward the observer, who should be at a distance of about 10'. The card with the hole is held in front of the eye, the back of the card being illuminated by means of a small, shaded light. Two images of the hole are formed, one by direct reflection from *x*; the other by triple reflection from *z*, *y*, and again from *z*. If the two acute angles of the prism are equal and there is no lateral distortion, as in *F*, the singly and triply reflected rays will coincide and one image only will be seen.

"If, however, the acute angles are unequal, as in *D*, the triply reflected ray will follow the course shown by the dotted line in *H* Two images will be seen, displaced vertically, as in *J*, or, if the error is slight, the spot will appear elongated.

"In the case of lateral distortion due to pyramidal error, as in *F*, the triply reflected ray will be displaced in a plane perpendicular to the paper, and the images will be displaced horizontally, as in *K*. If both errors are present, the images will

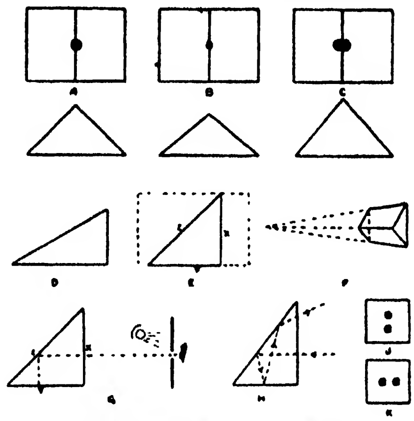


Figure 6: **Wates' prismometry**

be displaced or elongated more or less diagonally.

"It is important to note that the triple reflection test is not a proof that the acute angles are 45°; only that they are equal An isosceles or equilateral prism will also give a single image; therefore the Porter-Pierce test must first be applied to determine the angle between the square faces Note also that the condition shown in *F* is perfectly consistent with all three angles being correct.

"As to the sensitiveness of the test, it should be easy to observe an error of 5' of arc, which is the generally accepted standard for a satisfactory telescope prism. I have a 2" prism by a noted maker which shows no trace of elongation; I have another prism—a 1" "pick-up" job from a pair of field glasses, which shows two images separated by the whole width of the face, at a distance of 4'

"It is not suggested that the above test should replace the still more precise standard shop methods used by prism makers, but for checking at home prisms of doubtful origin and quality its simplicity should recommend it to amateurs."

The still more precise method of testing prisms, alluded to by Wates, consists essentially of a refinement on the methods he describes Light from an artificial source, a narrow slit mounted in the optical axis of a telescope, passes through its objective and into the prism, which is placed at a distance of a few inches. It is there reflected internally, and returned by way of the same objective to the eye. If, under magnification of about 25 diameters, the returned image of the slit coincides with the slit itself, the prism shows no error greater than approximately two seconds of arc. This is the test by autocollimation.

Printed in the U S A Press of the Wilson H. Lee Company, Orange, Connecticut

CHECKING the temperature of his electric furnace with a pyrometer, the research engineer shown on our front cover is continuing his search for better magnetic materials for transformer cores The story of this important work is told in the article "Regimenting Atoms," page 60.

•

SCIENTIFIC AMERICAN

Owned and published by Munn & Company, Inc., Orson D. Munn, President; I. Sheldon Tilney, Vice-President; John P. Davis, Secretary-Treasurer; all at 24 West 40th Street, New York, N. Y.

NINETY-NINTH YEAR — **ORSON D. MUNN, Editor**

FEBRUARY • 1943

SCIENTIFIC AMERICAN, February, 1943. Vol. 168, No. 2. Entered at the New York, New York, Post Office as second class matter June 28, 1879, under the act of March 3, 1879; additional entry at Orange, Connecticut. Published monthly by Munn & Co., Inc., 24 West 40th Street, New York City. Copyright 1943 by Munn & Co., Inc., Great Britain rights reserved. "Scientific American" registered U. S. Patent Office. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage. Illustrated articles must not be reproduced without written permission; quotations therefrom for stockselling enterprises are never authorized. Files in all large libraries; articles are indexed in all leading indices.
Subscription rate $4.00 per year. Canada and foreign $5.00

OUR *Point* OF VIEW

SCIENCE STUDIES RUBBER SOURCES

AND so, in the war emergency, it was finally decided to turn to synthetic rubber as the nation's best bet—at least for the short-time pull—and most of us agreed that this was a practical solution.

And the daily tumult died away, when those who had sincerely believed that certain vegetable, or plant, sources of emergency rubber were the best bet, found that they had not won, and got behind the synthetic plan that was adopted and helped push Whereupon, the old argument slid off the front pages of the newspapers.

No one should run away with the idea, however, that we have heard the last about rubber from plant sources. Quietly it is receiving most careful attention. As soon as the decision to go for synthetic rubber for the immediate need was made, it became possible for a large corps of scientists and technologists to begin a study of plant sources of rubber, unhampered by urgencies and other expediencies Thus, we shall hear from time to time of the quiet, calm research that is proceeding.

Goodrich, for example, is specializing in the careful study of three rubber-producing plants that seem at present to look best to its scientists—the well-known goldenrod, the Russian dandelion, called kok-sagyz (pronounced, according to the Russian-American Chamber of Commerce, "kuk sag-iz"), and a twining vine heretofore little publicized, called Cryptostegia This is a perennial which grows wild in Mexico (but has no relation to guayule, which also grows wild in Mexico) and contains rubber latex in all its parts The tips can be harvested 30 times a year. We may hear more of these hopes.

Then, if ways can be found to handle this weed, it is believed that the same ways will enable us to handle others that grow wild in every fence corner—dandelions, dogbanes, wild lettuce, and others—all of which yield some rubber.

On common fence-corner plants, the New York State College of Agriculture, at Cornell University, has been doing outstanding research, between 1500 and 2000 species having already been tested there. A method of testing a given plant or weed in five minutes was developed A thin section of leaf, stem, or root is cut by means of a razor, placed on a microscope slide, stained with a dye dissolved in solvents, and examined The stain renders rubber and accompanying resins visible. If the test gives promise, the plant is later analyzed quantitatively in the laboratory. (A very crude, though simple, field test is to rub out a leaf between the fingers. If the milky latex coagulates into a cohesive ball, there probably is some rubber in the plant. How much rubber is, of course, the next question.) Cornell also grew the Russian kok-sagyz last summer and gained a better production than the average Russian yield, but this plant remains on the doubtful list.

So ineluctable are the basics of economic law that, when the war is over, our permanent source of rubber will be the one which can produce it most cheaply—unless, of course, some artificial obstruction is permitted to interfere with the pure logic of economic law. If synthetic rubber from petroleum, or limestone, or other source, or, if synthetic rubber from one weed, or plant, or another; or, if even the old Hevea rubber tree, proves to be one cent or even one mil per pound less expensive, then that will be our future rubber source.

It has been said, for example, and rightly, that in normal times the rubber industry would have had to buy its plantation rubber from the opposite side of this planet, even if the suburbs of Akron, Ohio, had been a forest of rubber trees—the decisive factor would have been labor costs

In the meantime, while we let the facts decide on our future source of rubber, the rubber chemists who are now holding the fort with their work on synthetic deserve the nation's thanks There is pretty solid ground for the assertion that they are right now saving our future skins.—*A.G.I*

ECONOMY

VARIOUS, indeed, are the interpretations which are placed on the word "economy." It may call up visions of the housewife stretching the wage-earner's dollar to cover steadily increasing costs of living; it may bring to mind the whole process of national management; it may be applied to those common-sense—or necessary—means by which an industry continues to manufacture a needed product after many of its sources of conventional raw material (often all of them) have been cut off. A case in point is the alarm-clock industry. These mechanisms, largely composed of essential brass and often housed in a casing of the same material, have been placed on the "verboten" list. But workers, and war workers in particular, must have alarm clocks if they are to report for work on time. What to do? Practice economy, put into operation the common-sense procedures of economy that would be used under ordinary stress of economic necessity. The result is the so-called "victory" clock, reported at the time of writing these lines to be made largely of non-essential materials with cases of thin wood or plastics of the less costly and more largely available types

What the alarm clock industry is doing can be—and in many cases is being—done by other industries. Not only is this true of civilian products but of military or war-required materials as well. (Incidentally, the line between these two classes is becoming more and more difficult to draw, as the needs of the civilian over-lap more and more on those of the military, and vice versa.) Scientific research is constantly uncovering new ways of doing old jobs; new materials which replace, and do a better job than, older ones; methods of procedure which make former practices as out of date as the one horse shay. Applications of such research are constantly reflected in these pages, where is told the running story of industry and the benefits which it constantly draws from science.

Leaning away, for the moment, from practical things as they are being accomplished today, but still touching on science and "economy," as the word is applied here to the alarm clock and other industries, perhaps no better example of long-range research and its ultimate economy can be found than that being devoted to natural domestic sources of rubber, dealt with in the preceding editorial on this page.—*A.P.P.*

72696

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of February, 1893)

PANAMA WON—"The present outlook for the completion of the Nicaragua Canal is far better than for the Panama, but they both seem to be hipped in the same way. It is simply a question as to which company can first get the necessary funds. *F. R. Brainard, U. S. Navy.*"

LONG DISTANCE—"February 7 of the present year, witnessed the opening of the telephone line from Boston to Chicago. Telephoning is successfully carried on over 1250 miles of wire, owing to a somewhat circuitous route followed by the line. All distances hitherto covered are insignificant compared to this. The possibilities it holds for the future cannot well be overestimated A step beyond Chicago and the banks of the Missouri will be reached, and we may yet see Omaha and San Francisco connected by a line which will form the final link in a chain bringing San Francisco and New York within speaking range of each other."


First phone call over Boston-Chicago line

ARMOR—"A Harvey nickel steel armor plate, 6 inches thick, was tested on board the *Nettle* at Portsmouth on the 17th ult The 6 inch breech loading gun was used, firing Holtzer's forged steel projectiles weighing 100 pounds each. The trial was of a very unusual kind, the gun and projectile being those regularly employed for testing 10½ inch plates. . . . This is a most remarkable trial, for it must be borne in mind that the resisting power of a plate is more as the square of its thickness than as the first power, so that for a 6 inch plate to break up a projectile which until recently was a match for 10½ inches is a great triumph."

FAIR LIGHT—"Invitations have just been received in Chicago from the Westinghouse Electric and Manufacturing Company, asking an inspection of some of the electrical apparatus which is to form part of the incandescent lighting plant at the Columbian Exposition, and which is now exhibited at this company's shops, previous to its being shipped to Chicago. The feature of particular interest at this display is one of the 10,000-light dynamos direct coupled to a 1000 horse power Westinghouse compound engine."

TELESCOPE—"It is proposed in Paris to construct a gigantic reflecting telescope, the mirror of which is to be 10 feet in diameter and the length of the tube is 140 feet. It is to be ready for the exhibition which is to be held in Paris in 1900 The mirror is to be silver on glass"

BRIDGE—"One of the two or three highest bridges in the world is the viaduct over the Pecos River, Texas. . . . It is on the line of the Southern Pacific Railway, and its construction shortens the former line of the road by 11.2 miles, besides saving some heavy grades and avoiding bad curves. . . . The Pecos River bridge is 2,180 feet long between abutment walls, and it is built of plate and lattice plate girders resting on steel towers. . . . The height from the base of the rails to the surface of the water is 320 feet 10¾ inches, and to the bed of the river is 330 feet."

ONE REASON—"The fact that people lost on a desert or in a forest . . . walk in a circle is due to slight inequality in the length of the legs. Careful measurements of a series of skeletons have shown that only ten percent had the lower limbs equal in length, thirty-five per cent had the right limb longer than the left, while in fifty-five percent the left leg was the longer. The result of one limb being longer than the other will naturally be that a person will unconsciously take a longer step with the longer limb, and consequently will trend to the right or to the left, according as the left or right is the longer, unless the tendency to deviation is corrected by the eye."

BALLOON—"A large dirigible ballon is being constructed at the military balloon works at Chalais-Meudon, under the direction of Commandant Renard. It will measure about 230 feet in length and 43 feet in its greatest diameter. By a new arrangement of motor it is expected to be able to make headway against air currents not exceeding 40 feet per second, or 28 miles an hour The motor is not fully described, but it will act either with gasoline or the gas of the balloon, giving an effective force of 45 horse power."

COBALT—"Cobalt is now bought up in bulk by two or three chemical manufacturers, and is almost entirely used at present for blue coloring of glass and pottery and blue glaze. Its cost in reality is not more than that of nickel, but it is retailed at something about five times this cost. If cobalt plating, as suggested by Dr. Silvanus Thompson, were to come in, cobalt, being used more largely, would soon become as cheap as nickel."

SKI-TROOPERS—"There are now being made in certain corps of the German army some very interesting experiments relative to the introduction of snow shoes, to permit of marching and service on a campaign in the severest weather. The snow shoes used by the German soldiers are the same as those that have been employed for centuries in the countries of the north of Europe. . . . They consist of a thin strip of wood about a yard in length, a little wider than the foot, curved at the extremity and shod with iron."

Telephone wire coming up

Here's a bomber-gunner hurrying to load his 50-calibre gun. . . .

In peace, a lot of that copper would have gone into new telephone lines. Now it's needed for shooting and winning the war.

That's why we can't build new lines right now. That's why we're saying —"Please don't place Long Distance calls to war-busy centers unless it's absolutely necessary."

Thanks for all your help and we hope you will keep remembering.

BELL TELEPHONE SYSTEM

WAR CALLS COME FIRST

99TH YEAR SCIENTIFIC AMERICAN FEBRUARY 1943

'WE DEFEND WHAT WE BUILD'

Seabees, the Fighting Technicians of Our Navy

A. D. RATHBONE, IV

TAKE a map of the world and mark crosses on or near any points you like outside the continental limits of the United States where the Navy has been reported in action Chances are you will have indicated some Seabee bases. From the Aleutians to the Solomons, from Trinidad to Iceland, from Murmansk to Australia, in many lands and climates, north, south, east, and west, the Seabees have gone to work and to fight. With a brief history, thus far, but a vivid one, the Seabees — who derive their name from the phonetic pronunciation of the letters "CB," Construction Battalion—comprise the newest branch of the Navy, and one of our most dramatic and romantic services.

The wartime business of the Seabees, the broad knowledge and variegated skills of officers and enlisted men, the amazing and forceful esprit de corps they have conceived in a year's time are all best conveyed by a description of their insignia, an escutcheon destined to become as universally familiar as the blue of our Navy, the khaki of our Army, or the symbol of our Marines.

A zooming bee, with white Navy hat perkily cocked above the fighting-mad expression on his tough face, with spitting Tommy-gun in his fore hands, streaks across the hawser-encircled blue background of the insignia. Indicative of his technical ability, he carries a wrench in his second hand, a hammer in his rear fist. His several sleeves respectively bear Naval rating badges of Gunner's Mate, Machinist's Mate, Carpenter's Mate, and on each wrist is the corps device of the Civil Engineer Corps of the Navy, portraying relationship to the Bureau of Yards and Docks, the parent organization of the construction regiments. This rough-and-ready, tough little guy of many parts expresses better than whole columns of words the motto of the Seabees: "We Defend What We Build"

Are you a blacksmith, carpenter, electrician, mechanic, painter, pipefitter, plumber, rigger, steelworker? Can you operate a bulldozer, gas and Diesel engines, a dredge, a crane, a shovel, a truck? Do you know a good deal about generators, evaporators, water purifiers, refrigeration, welding, excavation, dynamiting, concrete, surveying? Maybe you're a cook, a baker, a laundryman, a draftsman, a rodman, a sailmaker, a telephone man, a wharf-builder, or a diver. Perhaps you are a doctor or a dentist If you are among these, or can qualify with knowledge and experience in any other technical line; if you're over 16 and under 51, still in good health, and want to line up with a two-fisted crew of really tough hombres who fight with one hand and build naval bases with the other, you may volunteer for service in the Seabees If you're looking for a commission, you'll have to be a college graduate with an engineering degree. The Construction Battalions of the Navy are truly specialist outfits, and it is their stiff requirements of engineering and construction experience that makes them so.

The Seabees were born a child of necessity and have grown to manhood within the short space of time since the Japs took Guam, Wake, Cavite, and other advance base facilities of the Navy. The story of unarmed civilian construction men on Wake Island during the heroic stand by Major Devereaux and his little band of Marines, and the part the civilians played, after grabbing anything that would shoot, is well known. The lesson was quickly learned and shortly after the declaration of war the need for construction personnel at many locations outside the United States became apparent. That this force should be in uniform and under military command went without saying, with conditions as they were. The Navy's Bureau of Yards and Docks authorized its Civil Engineer Corps, which, through the medium of individual civil engineers, has served the Navy since 1775, but as a unit with authority to command only since 1942, to recruit one

regiment of three battalions, totaling approximately 3300 officers and men. That was in December of 1941. By mid-November of 1942 the Seabees were authorized to enlist 210,000. After training, each battalion is a complete entity unto itself, each of which can build or tear down anything constructible, each of which is seeing service somewhere on the far-flung fronts of this war, and each of which has been trained to protect and defend what it builds.

At the special training camps for men of the Construction Battalions at Norfolk, Virginia, and Davisville, Rhode Island, volunteers have been arriving for months. These "boots," as new Navy men are termed, are assumed to have had varying amounts of technical training or experience, depending upon their age. They have filled out lengthy applications which tell the story of their various skills, they have had their physical examinations, and "boot school" will teach them how to drill, salute, shoot, wear their Navy uniforms, and generally conduct themselves as Navy men should During the three weeks of this specialized boot school the men who some day will build on the borderlands will also learn military courtesy, the manual-at-arms, combat signals, rifle marksmanship, extended order drill, the techniques of the .45 pistol, hand grenades, the Thompson sub-machine gun. bayonet drill, the layout of bases, and principles of air-raid protection.

The "boots," upper left, learn first principles of drill, while those with guns are further advanced. In background are Seabee road machinery and stacked rifles

The dynamite crew sets a charge

It's a tough schedule, that first three weeks, and it catches many an old-timer with short breath, weary and strained muscles, and perhaps a secret admission that he isn't quite the man he thought he was. However, all drill, calisthenics, and physical endeavor—and there's plenty of it from reveille at six in the morning to taps at 9:30 at night—is carefully watched by medical men, and the older members of the battalion are urged to take it easy until they once more become the toughened men they were in bygone years. As for the younger fellows, there's no more need to worry about them than if they were in the Army, the Marines, or other branches of the Navy, and the story is about the same

Quite naturally the emphasis is on the military scheme of things, for these men already know their trades However, there is technical training in lecture hall and in laboratory, or in specially designed practical work shops. There are talks and actual labor on boilers and heating, Diesel and gas engines, evaporators and purifiers, generators and electricity, air-raid protection and camouflage, pontoons, propulsion units, and drydocks, tank and radio mast construction, refrigeration, welding, small arms, concrete forms and carpentry, diving, excavation and earth moving, hut erection and fire-fighting. The latter four will be covered still more in detail and actual practice after the men have left Camp Allen, at Norfolk, for the advanced training at Camp Bradford, not far away.

In the course of this formative period the new battalion finds itself. Men who have acquired particularly specialized backgrounds are discovered through a series of new questionnaires and by discussions with the officers These men, picked from the ranks, are given supplementary and extensive instruction in the subjects listed above. they are excused from routine duties; often they end up by being instructors, which means they are likely to remain at Camp Allen for some time to come. One of these, for example, a specialist in Diesels, enlisted in April, 1942, and, much to his annoyance, he is still teaching the newer men the intricacies of his trade Although 48 years old, father of four daughters, and a three-times grandfather, he is thoroughly disgusted with his lot of "fighting the battle of Virginia," and admitted to having deep, dark plans for "selling" the idea to the commanding officer of the next battalion to go through the school that he should be sent out to build and fight, rather than remain in the role of instructor.

● Through the courtesy of the Navy Department, a member of our staff visited one of the three training camps of the Navy's new Construction Battalions, known as "Seabees." These men, many of them veterans of the last war, are performing a vital service in the establishing of advance bases in all parts of the world, a service unique in the annals of the United States Navy, and one fraught with danger, which is why the Seabees are taught to fight with one hand while they build with the other. Illustrations are U. S. Navy Official Photos.—*The Editor.* ●

If a man wants action in foreign lands in this war, he'll get it in the Seabees. As soon as a battalion has been formed and has completed its training, it leaves for "Island X," which is the designation for an island, a continent, an isthmus, a beachhead anywhere in the world. When a battalion leaves the United States for its objective, it is as complete and sufficient unto itself as American ingenuity and inventiveness can make it. Food, clothing, arms, and ammunition are but a few of the impedimenta. There must be huts to live in, a laundry, a dentist's. and a doctor's office and their paraphernalia, kitchens that cook while they roll or during tropical hurricanes, or in northern blizzards; in fact, under all conditions. But even that is only the beginning. There men are sent out to

A powered pontoon landing barge, loaded to capacity with men, machinery, and tons of many kinds of materials, chugs its way toward shore in practice maneuvers

construct something That means all manner of road building and concrete machinery, it calls for welding and acetylene cutting apparatus and the Diesel, gasoline, and electrical power to run them, it means tons of concrete, reinforcing iron, and the lumber for forms, tanks for the storage of water and engine fuel In short, try to visualize a safari of over a thousand men with everything they'll need for months from toothpaste to aspirin, roast beef to a cold glass of beer, work gloves to a new pair of pants Then add your list of all conceivable equipment, machinery, and materials to build a city in which to live, to carve an airport out of a jungle, to build storage bases and landing facilities on a coral reef That is a Seabee battalion

To prepare the men and officers for what they will run into, there are five weeks at Camp Bradford, a sprawling wilderness of sand, swamps, and pine trees on the Atlantic coast There huts are built and torn down, storage tanks ranging in capacity from 1000 gallons to 10,000 gallons go up sectionally in jig time, and come down just as fast. Stumps are dynamited, carpenter crews slap together concrete forms just about fast enough to keep ahead of the mixing and pouring gangs. Roads of steel mesh through the rough and sandy country offer engineering problems of the first magnitude and provide field practice for bulldozers, shovels, cranes, scrapers, and for welders and their mobile units The amphibious side of the Seabees is developed by working with the versatile pontoons, from which are built piers, bridges, drydocks, and landing barges. One important point must be noted As the new battalion passes through the screen of officer and instructor observation, each man is sifted into the niche for which he is best fitted in this outfit of super-specialists. The battalion is really an organization of highly trained crews of metal workers, carpenters, concrete men, welders, and so on. While each group has its specific work to perform, it is part of the Seabee scheme of things that all will turn to and serve as helpers to any other trade The heavy stress laid on this phase of training, and the astuteness with which the entire program has been laid out, is what makes a battalion of Seabees such a closely knit unit, gives it such excellent teamwork, and enables it to accomplish the seemingly impossible in faster than record time

In the course of an early lecture an instructor tells the Seabees that· "The purpose and duty of the Construction Battalions are to erect, reconstruct, or repair advance bases, or to extend existing facilities on an island, or possibly some mainland. The area may or may not already be occupied by the Navy, the Army, or the Marine Corps Seabees *may* have to clear an area of enemy forces, and their duty *may* include holding such an area"

To lend authority to this theory of action, and to provide practical instruction, realistic landing parties are staged in which the Seabees must attain their objective against "enemy" troops armed with flour bombs, and perhaps entrenched in fortifications and equipped with armament Powered pontoon barges are loaded with everything the battalion will need for such a task on "Island X" The Seabees, too, are equipped with flour bombs, and at the signal, the landing party starts towards a windswept, sandy beach, held by the "enemy"

In one such maneuver two companies of Seabees were given the task of effecting a landing, clearing the area of the enemy, and constructing a 1500 foot runway for airplanes on a sandy beach, besides establishing their own living quarters and bases, providing themselves with a supply of fresh water, mounting their own guns, and making other preparations for a possible enemy counter-thrust They were allowed 30 hours in which to complete the assignment

The chugging barges poked their blunt noses as far toward the beach as possible. Hundreds of carpenters, welders, crane men, metal workers, and other technicians who, by now, were trained combat men in the pink of physical condition, leaped into the sea up to their knees and waists, with rifles and light machine guns, and charged toward land The shore end of the barge unfolded into a ramp down which

On "Island X" Seabees lay steel mesh on sand for road foundations, then camouflage mesh with finely ground coral, which eventually cakes into hard surface

more machine guns and a small field gun were trundled to the beach and set up. Meanwhile, flour bombs had begun to fly in all directions, with ensuing casualties on both sides. Some of the precious Seabee machinery and material was hit, which invalidated it for use in completing the task, and several of the men were put out of action The attack was fast and furious for a few minutes, but such was the impetus and enthusiasm of the fighting technicians that the enemy were overcome and captured.

Practice maneuvers at Camp Bradford include frequent use of Navy landing barges, service trucks, and many other special forms of machinery and Seabee equipment

INSTANTLY the scene changed from that of a battlefield to a fast-moving and well organized construction camp. Bulldozers and scrapers came ashore, dynamite crews followed surveyors' instructions and blew up stumps, rocks, trees, and other obstacles in the proposed runway. With perfect precision one crew followed another, each acting as helpers when not engaged in applying its own primary technical skill A tiny village of huts popped up in the pine trees like magic, the energizing aromas of hot coffee and soup came from the rolling kitchen, the water evaporator went into immediate action to produce a fresh water supply from the sea, the roar of road machinery and the hum of generators competed with the smack of busy hammers and the rattling of concrete mixers.

In appropriate places anti-aircraft guns were mounted, and a continuous stream of crates, bundles, packages, and more machinery continued to come ashore In fact, the Navy's Construction Battalions might well be known as "the hook-and-eye" service, for everything they own or work with is equipped with large or small rings so that the cranes and derricks, or men, can hook into and lift them from transport ship to pontoon barge, from barge to waiting truck, and from truck to proper location Even the laundry, capable of caring for either a 200-bed hospital or 900 men in a 16- to 20-hour day, comes in three huge "eyed" crates When these are spotted, when pipe and other operating connections are made, when the water tanks are filled by the supply of fresh water from the already installed evaporator, and the Diesels are fueled, the laundry starts to hum

All this and far more those two Seabee companies accomplished in the limited time allowed for their mock invasion. The airfield runway was finished, guns and crews were ready for any return of the "enemy," and a village of over 1000 men was in full operation with water, lights, power, and even medical and dental quarters —in the amazing and unbelieveable time of 26 hours continuous work. Of such men are the Seabees made.

The determination of those comparatively few construction men who were on Wake, Midway, and other Pacific islands when the Japs so ruthlessly attacked them burns ever stronger within the Seabees This is one reason for the amazing esprit de corps among this newest of fighting services. Even the first battalion to go overseas, soon after the Navy directive established the Seabees, was imbued with this remarkable fighting spirit from first man to last Their ship was attacked, and the fighter-builders proved they were not mere super-cargo by helping to man the guns which drove the enemy away. These seagoing landlubbers can build anything anywhere, under any conditions, and will fight to prove it

This will soon be a 10,000-gallon storage tank. During training, the Seabees put them up in record time and then tear them down again, all for the sake of experience

DRAWN from every technical walk of life, they are among the best in the nation They include many veterans of the last war, their sons and nephews. Many are men who have given up high-salaried positions for a far lower income A Seaman 2nd Class in the Seabees receives $54 a month for home service and $64 80 while abroad, a Chief Petty Officer commands $126 at home, and $161.20 overseas, so it isn't money that activates men to join the Navy's Construction Battalions — it's something else

A man becomes a Seabee because he has that "something," a "something" the Japs and the Nazis, to their regret, are going to know far more about before the thousands of men who fight with one hand and build with the other are through with their business at hand.

Salvaging Light

How More Light May Be Supplied to Industrial Workers Without Increasing Current Consumed

A. P. PECK

By means of a scientific use of color it is now practical to increase the illumination from most light systems 100 percent without any change in lighting equipment or any increase in wattage. That challenging statement was made as the result of studies recently reported; the data presented in the report, and applications of the system investigated by the writer, bear out completely the broad claims made This scientific use of color was arrived at as a result of continuing research in the "three dimensional seeing" work reported in the December 1941 issue of Scientific American, when properly selected paints were being used to tint parts of machinery with outstanding results in matters of better seeing and greater safety

In the present work, the investigators, co-operative workers from Du Pont and the Philadelphia Electric Company, extended the study area from the machines themselves to include the entire room, and bent their energies to devising colors and color combinations that would reflect light to greatest advantage

It is well known, of course, that light colored walls increase the illumination in a room by reflecting available light Actually, however, this method of light utilization has been sadly neglected in the past and only now has been subjected to careful study. In many an industrial plant, a well-designed lighting system is robbed of its efficiency by dull, dingy ceilings, walls, and floors. In others, where walls and ceilings have been painted with light-reflecting finishes, some of the light has been salvaged Even in such cases, however, a considerable amount of light is lost, "blotted up," by dark, drab floors.

To the uninitiated it might seem, off-hand, that the ideal solution to the problem of light utilization would be to paint all surfaces a dazzling white. Then the light rays could bounce from wall to ceiling to floor in an endless cycle of utilization. True enough, such treatment would result in extremely high values of light at the working surfaces, as compared with the wattage of the source, but other factors would enter that would make the method impractical.

First, any surface that reflects too much light will produce glare. Then, the psychological effects on the workers must be considered, an all-white room would be uncomfortable to work in, aside from the glare, and would be considered an unpleasant environment Third is the matter of maintenance, a factor of great importance in industry, where ceilings and walls cannot be painted or cleaned too often without undesirable expense and interference with normal operations

The word "utilization," used above and farther on in this article, should be explained in its specialized sense before it becomes misunderstood. Of course, it means "use," but to the lighting engineer it has a definite mathematical meaning widely employed in his work. Illumination is measured in terms of lumens (light units) per square foot falling on an arbitrary plane, usually horizontal and 30 inches above the floor The area in square feet of this plane, multiplied by the illumination in footcandles, gives the number of useful lumens. This figure, divided by the rated lumens of the lamp or lamps, is called the coefficient of utilization, or merely "utilization."

Working with such a measurement system, preconceived ideas about paint and light were put to practical test by the research workers They had available a test room 11 feet 4 inches wide by 22 feet long with a 10-foot ceiling, illuminated by two 500-watt silvered bowl incandescent lamps on 18-inch drop cords. The ceiling and walls were white, the dado was gray, the floor was maroon, and the furniture was dark mahogany. Industrially, there was nothing much wrong with the room, except that the white paint had lost a great part of its reflection value; it was the sort of room that will be found duplicated many times in many places, and is shown as an inset in the accompanying chart.

When the engineers first started experimenting with this room, the light utilization was only 27 percent When, however, the ceiling was given a coat of light cream paint, with a reflection factor of 85 percent, the utilization coefficient jumped to 33 percent, an increase of 22 percent just by the selection of the correct paint for the ceiling alone.

The next step consisted of applying to the sidewalls a neutral green paint slightly on the yellow side in hue, and having a reflection factor of 72 percent The original finish had a reflection factor of 40 percent and the gray dado a factor of 12 percent. This change in the sidewall finish resulted in an improvement in light utilization of from 33 to 44 percent Parenthetically it is noted in the technical report on this work that the men working in this room found the changed color scheme

Color treatment of machines, plus light floor areas, increases visibility

quite comfortable and had no adverse comments to make. This factor of psychological effect on workers cannot be too strongly stressed in considering light salvage methods. If light is saved at the expense of mental irritation brought on by color effects, the work done is useless, or worse

After the effect of the sidewall change in the test room was fully determined, the research workers next refinished the floor, which had a reflection factor of 12 percent, with a white deck paint having a reflection factor of 85 percent. This brought the room utilization up to 56.1 percent. When the dark mahogany furniture was replaced with blond furniture having a reflection factor of 50 percent, the light utilization climbed to 58.5 percent, or a total increase of 113 percent over the light utilization of the original room.

Here was dramatic proof of the ability of engineers to double the effective lighting in a given room without increasing the power consumption of the light source.

One final change was made in the test room which brought the room utilization down to 55 percent: In the interest of easier maintenance, the white floor was stippled with russet paint, bringing its reflection factor down from 85 to 70 percent. Still, the gain was in excess of 100 percent over the original

This last mentioned matter of reducing the reflection factor of the floor for maintenance purposes has one other advantage When the floor surface reflects more than about 70 percent of the light impinging on it, the result, over a period of time, is likely to be irritating to the human eye. Our eyes are mechanically so constructed—sockets, brows, and so on—as to receive light from above with the greatest comfort When light in large amounts, relative to the total, reaches our eyes from below the horizon, a sensation of discomfort is created and workers cannot produce at their best.

According to the engineers who did the work with the test room, the experiments established three things: Satisfactory hues may be secured without serious sacrifice in reflection properties, floor and table finishes of 65 percent reflection factor, or even higher, are practical; coefficients of utilization of the order of double the present practice can readily be secured by the use of high-reflection floor finishes of suitable hue.

But the test room was by no means the end of the work with light salvage. The possibilities had been proved and next must be applied in practice. In the repair machine shop of the Philadelphia Electric Company the floor was coated with a paint having a reflection factor of 60 percent. This change greatly improved the machine-operators' ability to work at the various machine tools, particularly when brass and copper were being fabricated On an aircraft assembly line a similar paint change gave increased visibility on the parts under construction.

The light floor of this assembly line reflects light to needed places

Probably the most outstanding application of this recent research to industry, however, is in the plant of the Ordnance Gage Company in Philadelphia. Here a group of highly skilled workmen produce precision instruments with tolerances running into the infinitely small Good seeing is essential. To all machinery has been applied the "three-dimensional seeing" system of painting mentioned previously. The ceiling has been painted white and reflects 85 percent of the light which strikes it. Reflection factor of the buff sidewalls is 72 percent, of the green dado 50 percent, and of the dust-green stippled floor 70 percent

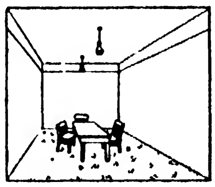
The overall effect of this color combination is one of striking cheerfulness and light. The workmen are thoroughly pleased with their surroundings, they like the colors and the amount of available light, and do not miss an opportunity to say so in no uncertain terms.

From a careful consideration of the investigations described above, it is apparent that only by the use of interior finishes having a very high reflection value can we expect a maximum utilization of light. This applies just as well to floors, furniture, machinery, and benches as it does to ceilings and sidewalls Since these high reflection values do not permit efficient and comfortable vision through "brightness" contrasts, it is obvious that such vision must be obtained through contrasts in hues. Hence much of the present research has been concentrated on paint hues, defined as the quality by which we distinguish one color from another, such as a red from a green, and so on.

"The function of color," states the technical* report of the co-operating research workers on this light-salvaging program, "as a part of the industrial seeing machine is to provide a controlled mild stimulation and to increase visibility by means of suitable contrast. Brilliant colors, such as bright red or yellow, stimulate impulsive action and have their place as danger and caution indicators. Under such conditions, pronounced stimulation is deliberately produced in order to get instant action. Preventive action must be instantaneous if accidents are to be reduced Achromatic colors (gray) have a deadening effect if used to the exclusion of chromatic colors, *i.e.*, those having hue. . . . Somewhere in between strong chromatic color and achromatic color lies the position of continuous, comfortable, accurate vision with a minimum of fatigue. The need of the correct degree of stimulation within the working area cannot be disputed. It is equally essential, however, that the hue and brightness of the surroundings, including floor and ceilings, must be of such character as to emphasize a return of the eyes to the working

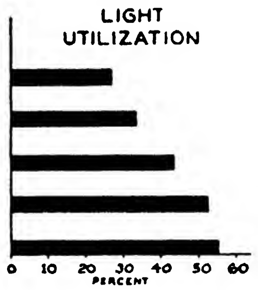
***Readers who are interested in more specific details on this subject will be referred to technical sources on request to the author.**

STEPS TAKEN TO SALVAGE WASTE LIGHT IN EXPERIMENTAL ROOM



LIGHT REFLECTION ... PERCENT

	CEILING	WALLS	FLOOR	FURNITURE
START	65	40	12	20
2	85	40	12	20
3	85	72	12	20
4	85	72	70	20
5	85	72	70	50



☆ *IMPROVEMENT DUE TO "SALVAGE" 102%*

How light reflection (and utilization) was stepped up

area and to have their greatest comfort while there In addition, these areas should have an adequate reflection value to insure the maximum use of multiple reflections. . "

The investigators of salvaged light sum up their report, which they emphasize is a record of progress rather than an ultimate solution, with the following facts:

"That carefully selected hue contrast will effectively augment brightness contrast for comfortable, accurate, continuous vision

"That it is quite feasible to use much higher reflection factors on floors and walls, without discomfort, than has hitherto been considered possible

"That the use of color does not necessarily mean a great sacrifice in reflection factor.

"That the use of multiple reflections makes possible a degree of light utilization far in excess of existing experience with a consequent reduction in the need of critical materials and an increased return from the electrical power used"

Thus it will be seen that salvaging light for victory holds outstanding possibilities when approached from a scientific viewpoint Color as well as reflection quality of paint used in the process must be considered And planning, to be most effective, must take in all surfaces, from ceiling to floor to furniture to machinery When these are knitted into a light-salvaging whole, better seeing conditions will result without increased light bills

• • •

REGIMENTING ATOMS

In Search for Better Transformer Cores

Seeking a better magnetic material for transformer cores, a physicist at the Westinghouse Research Laboratories is "drilling" atoms as if they were a squad of Army recruits on the parade ground.

By melting and then slowly cooling an iron-aluminum alloy, Dr Sidney Siege gets atoms of the two metals to line up as orderly as well-trained soldiers. When they are arranged this way, the atoms exert their magnetic force together. Ultimate success of this work may increase the efficiency of electric transformers—the voltage-changers that are the key links in the alternating current system of power transmission. As a result, transformers will be able to do more work for their size This will save copper and steel, make it easier to transport and install transformers, and eventually reduce the cost of transmitting electricity to homes and factories

"A metal rod, 96 percent iron and 4 percent aluminum, is placed in an eight-inch deep porcelain crucible shaped like a test tube," Dr. Siegel said in describing his work, which is illustrated on our front cover. "Then a cylindrical electric induction furnace is lowered to surround the crucible which is held in a vertical position.

"After the furnace melts the metal, the heating unit is raised slowly from around the tube by clockwork, at the rate of an inch an hour. Complete cooling of the metal takes all day."

Slow cooling makes the rod a single large crystal in which the atoms are piled up in neat layers, just as sugar cubes can be stacked in a box, the Westinghouse physicist said. In such a crystal the magnetism of each atom points in a single direction, producing the maximum magnetic properties for that material Normally, a molten metal cools quickly and the atoms are piled helter-skelter with their magnetic forces exerted in many different directions. These forces counteract each other so that the magnetic effect is considerably smaller

Slices from the crystals are used in electrical tests to determine how efficient a magnet the material will make. With these slices Dr. Siegel builds one-inch square transformer cores, hollow in the center. The cores are built so that the magnetic forces point along the edges of the square as if pursuing each other.

Dr. Siegel intends to test other iron alloys until he finds the mixture that will give him the best possible magnetic material for use in transformers. It would be impractical, if not impossible, to make single crystals large enough for commercial transformer cores, he pointed out, but the material which tests best as a single crystal will probably be best when developed for commercial use

Dr Siegel's work is a continuation of Westinghouse research which resulted in development of Hipersil, an iron-silicon combination that is a one third better conductor of magnetism than any material used previously in transformers.

STEEL MAKING

Receives Electronic Science With Open Arms

Electrical engineers of the iron and steel industry have been among the most receptive users of new applications of electronic tubes and photo cells—employing these devices in many ways to control their industrial processes

As a result of this open-minded attitude toward electronic-tube apparatus on the part of the steel engineers, electronic devices now play an important role all along the line of steel production and fabrication.

This wide use of tube devices by the steel makers—an industry well-known for inflicting the most severe industrial punishment on its equipment—is therefore striking testimony to the fine performance of electronic equipment under terrific industrial stress.

And since steel making also involves enormous and heavy costly machines, continuously handling tons of molten metal at incandescent temperatures, the absolute confidence imposed in electronic devices to control these great

mechanisms, gives proof of the dependability and durability of present electronic apparatus.

In the production of steel, photo cells are used in both the open-hearth and Bessemer processes In the case of open-hearth furnaces, it is important to get the temperature as high as possible, yet not to endanger the melting or breakdown of the furnace and furnace roof

Photo-cell instruments enable furnace and roof temperatures to be continuously and accurately checked, so that safe limits are not exceeded.

In the Bessemer process, a critical index is the color of the flame from the converter, determining when the exact instant arrives for shutting off the "blow." Formerly, trained experts were necessary to supervise this operation and to judge the color changes exactly Now, photo cell color comparators are employed which detect the exact color-changes watched for, and give mistake-proof signals when necessary chemical reactions have been completed

Reversing mills and cut-off saws are now photo-cell controlled As huge incandescent billets come out from between the rolls, a photo-cell catches sight of the red-hot mass of metals and, at the precise instant, reverses the mechanism to send the billet back again through the rolls Cut-off saws operate in the same way, actuated by either hot or cold material

Strip width and centering are also electronically controlled in modern steel mills, eliminating close human attention For scanning strip for pinholes, photo-cells take the place of human eyes and throw out defective sections Many electronic tubes are also used in connection with control relays — *Orestes H. Caldwell, Editor of Electronic Industries*

CREEP TEST

Gives New Data to Turbine Designers

A 100,000-HOUR high-temperature creep test—the longest on record—for four rods of high-strength alloy steel, begun when Herbert Hoover was in the White House, was recently completed by the General Electric Company. The four rods represented one of the best known alloy steels for high-strength forgings and bolts required in the manufacture of steam turbines.

The test was made to determine what stresses could be used at temperatures where all materials are plastic, without causing deformations larger than the minute values tolerable in high-speed machines

A test of this duration also provides a means for studying the changes in the characteristics of the metal under prolonged conditions of high temperature and stress, and determines whether the material becomes stronger or weaker during the 11 years or the 100,000-hour period Such tests are necessary for improving the design of steam turbines so they can operate at higher temperatures

Left: A final check is made on the creep-test rods before removal from the furnace. *Above:* Withdrawing the first of the four 100,000-hour test rods

The rods tested were each four-foot specimens of nickel-chrome-moly steel (S A E 4340), 0 505 inch in diameter A 12-inch portion at the center of each rod constituted the test area. Temperature of the furnace was maintained at 842 degrees, Fahrenheit, the rods were subjected to constant stresses of 13,000, 17,000, 21,000, and 25,000 pounds per square inch respectively. In the 100 000 hours the No 1 rod with the constant stress of 13,000 pounds per square inch stretched 0 928 mils per inch of length, or about one thousandth of the 12-inch portion tested Extensions of the other three rods were 1 398, 2 729, and 4 166 mils per inch of length

PALLADIUM

Will Find Increased Use in Jewelry

COMMENTING on the recent order of the War Production Board restricting the use of platinum in jewelry, Charles Engelhard, of Baker and Company, Inc, leading authority on platinum metals in the United States, concurs in the recommendation of the Board concerning the use of gold and palladium instead of platinum. He states that the jewelry trade is indeed fortunate in that it has available, without restriction as to its use, ample supplies of these metals.

Mr. Engelhard advises that "palladium is available in sufficient quantities to furnish the jewelry trade with a satisfactory alternate for platinum, and that the major sources of supply lie in Canada, Alaska, and South America. Even though palladium is more rare than gold or platinum, as considered from the point of view of recovery from ores or other natural deposits, it is today possible to effect its recovery in worthwhile commercial quantities by modern metallurgical processes developed over the last decade"

He added that "palladium has been used for jewelry manufacture, sometimes in alloy form with other members of the platinum family. These alloys have the required strength and hardness for rings, and for the setting of gems with security, and they can be readily worked into delicate, lacy designs for pins, brooches, and other larger pieces"

Palladium is lighter in weight than platinum, is about as heavy as 14K yellow gold, and has a current market value approximating 70 percent that of platinum Its color is admirably suited for the setting of diamonds and it harmonizes with the colors of other gems

PINE PLASTIC

Resin and Vegetable Fibers in Newly Announced Material

A NEW plastic composition, which can replace steel or other metals in many uses, has been developed from vegetable fibers and a resin from Southern pine trees, according to G. R. Stark, vice-president of The Patent and Licensing Corporation. Mr. Stark said that the resin is made only by Hercules Powder Company from the wood of the Southern pine in its naval stores

plants in Georgia and Mississippi, and is now available without priorities.

Announcement of the new plastic followed within three months the announcement by Hercules chemists of another plastic, soft ethyl cellulose, found suitable to replace rubber in many articles.

Lightweight but sturdy, these new compositions can be used instead of steel or other metal for many purposes such as structural members, pipe, wall panels, air conditioning ducts, corrugated sheets, and so on.

To make this plastic, the resin-treated fiber is turned out in sheets on standard paper-making machinery. These sheets are hydraulically pressed together to make compositions which are hard, dense, stiff, but not brittle.

SYNTHETIC CORUNDUM

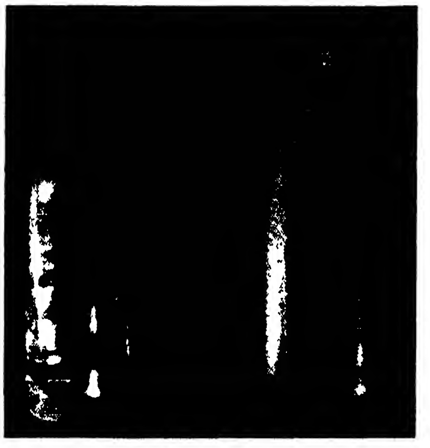
White Sapphire Now Man-Made-in-America

Synthetic white sapphire—the mineral corundum unpigmented and of gem quality—is now available in the form of boules, each weighing at least 150 carats and of a regular cylindrical shape, enabling gem cutters to standardize on cutting and sawing procedures. Instigated by the need of a domestic source of industrial gems, the manufacturer, The Linde Air Products Company, in less than two years equalled and, in some respects, has surpassed the quality of European gems, formerly the only synthetics obtainable. Since domestic production started, it has grown so that it is now capable of handling the entire military demand for all the United Nations.

Mineralogically, the hardness of the American white sapphire is exceeded only by the diamond. Once they are cut, the jewels are also surprisingly tough in terms of resistance to breakage by impact. Moreover, because they have a melting point of over 3700 degrees, Fahrenheit, they are also heat resistant to a high degree. An additional advantage is the boules' uniformity of size and shape, which leads to economical cutting.

Many essential uses are already being made of jewels cut from these synthetic boules. Among locations where they serve economically are as the jewel bearings of chronometers, compasses, and electrical, fire-control, and aircraft instruments. In such instruments, they are employed in the form of ring bearings or V-type and cup-type end bearings. Pallets are also made for watch escapements.

Other successful, although still experimental, uses of the white sapphires are as thread guides in the manufacture of rayon, as orifices for flow meters and oil-burning equipment, and as insulators in gas-filled or vacuum thermionic devices. Indications are that they are also suitable for use as Diesel-engine injector nozzles, as rollers for small needle bearings, and for cutting tool tips to perform high speed finishing operations on certain non-ferrous metals. Their complete chemical inactivity when exposed to all types of corrosion, except strong mineral acids and alkalies, may suggest additional uses to designers of chemical equipment.



American-made synthetic sapphire boules. At left is a 200-carat boule typical of present commercial production, while at right is one of the largest sapphires yet made—350 carats

• • •

PRESERVATION—The value of wood preservation—both for war and civilian use—is being realized, as indicated by the fact that in 1941 an increase of 20 percent was recorded over 1940 in the amount of wood preservation

• • •

SABOTAGE

War-Production Lines Are Well Protected

Saboteurs aren't going to have much chance to throw monkey wrenches into America's fast moving war-production line, if government plant protection officers have anything to say about it. Precautions being taken against enemy agents in war plants were described recently by Lt. Colonel James C. Sawders, chief of the plant protection and safety branch of the Chemical Warfare service.

Special attention is being given in all plants working on war orders to fire prevention, fencing, and protective lighting, investigation of personnel, hiring of new employes, adequate plant guard forces, and protection of confidential documents, blueprints, and special tools, Col. Sawders said. Vital plant facilities and equipment such as water supplies, power plants, and stores of industrial explosives are being closely guarded, he added.

Speaking of hiring practices in war plants, Col. Sawders said: "It is highly important that we know a lot about the people who work on important contracts. The infiltration of enemy spies into plants in positions of trust must be avoided at all costs. All employes in plants working on government contracts are now fingerprinted and a good portion are given physical examinations. We are particularly interested in the examination of food handlers since it is most essential that they have no communicable diseases."

Col. Sawders mentioned that good plant guards are hard to get. He defined good guards as alert and vigorous men of good health between the ages of 30 and 45. "Younger men are all right but men of more mature judgment are preferable," he said.

"I believe there are comparatively few misguided idiots who think our enemies are trying to build a better world or who, for pecuniary considerations are willing to risk their necks," Col. Sawders said, "but this does not mitigate the possibilities of sabotage and we must be continously on the alert. You never can tell when, where, or how those fellows will strike and you may be sure they will strike in places where it will hurt most, particularly if they are directed by enemy agents who are never selected for their work unless they are people of considerable talent."

PROTECTIVE CLOTHES

Are Flame-Proof, Resistant to Wear and Tear

A new type of protective industrial clothing known as Ply Garb is flame-proof, preventing serious injury from spontaneous magnesium fires and in other hazardous manufacturing operations. Made of featherweight but tough, plastic, laminated cotton cloth, Ply Garb sleeves and aprons offer maximum comfort and freedom of movement. The sleeves feature special air vents to guard against excessive perspiration. Ply Garb fabric is said to be sturdy enough to resist tears, snags on rough surfaces, and cracking. It is flexible enough, however, to resist wear and afford complete comfort.

INDUSTRIAL TRENDS

THE FUTURE IN THE AIR

Sunday supplements and occasional pieces in the daily press have pictured the aircraft industry in general as being in the chrysalis stage of becoming *the* transportation means of the future, awaiting only the end of World War II to burst forth and take over the entire job of railroads, automotive highway vehicles, and steamships In particular, these purveyors of news have dwelt on the cargo-carrying possibilities of the future, predicting all sorts of fantastic types, capacities, and species

There is no doubt that the airlines, the aircraft industry, and cargo carrying by air will leap forward after the war, stimulated by lessons learned and problems solved under the stress of military necessity How far these components of air transportation will leap, however, is subject matter for calm, serious thinking, based on past performances and present operations (so far as they are known under the limitations of military secrecy)

Probably the best way to guide such thinking is to harvest and digest a group of present and post-war "straws in the wind," gleaned largely from airline and aircraft manufacturer's reports, from the recent Air Cargo Engineering meeting of the Society of Automotive Engineers, held in Chicago, and elsewhere Thus

On the Airline Front: So great has become the demand for air cargo space that new commercial all cargo schedules have been put into effect by many of the major lines These services must not be confused with the military cargo service that the same lines are operating under the Air Transport Command of the Army Air Forces This new service is strictly commercial . Although the airlines have only half as many planes available as formerly, the heavy volume of business may be enough to enable the airlines to handle at least as much commercial business as they did a year ago, if not more . By the end of 1943, Army Air Force commanders have indicated, air cargo transportation will approach, if not reach, parity with wartime ocean shipping

One airline says that, although at the time of reporting they had only 3600 employees, the jobs they had been given to do would require expansion to possibly 10,000 employees . Compare this with the total personnel of all United States air transport groups, as reported by the Civil Aeronautics Board, of 23,890, as of June 30, 1941. . . . While practical airline operators do not share the over-optimistic views of some regarding the future, they are all certain of a substantial increase in business, once equipment and manpower are made available to them . . . Again referring to the CAB: It is their estimate that, assuming normal progress, and using as a basis the 12-month period ending April 30, 1942, six billion passenger miles will be flown annually by 1946, on domestic airlines. During the 1941-42 period mentioned only one and one-half billion revenue passenger miles were flown. . . To do this job the Board states that a seating capacity of 25,000 will be required, or the equivalent of 1200 planes of the size of the DC-3. This would be about five times the capacity of the 1941 domestic airline fleet . . . In international operations, and with similar qualifications as for domestic work, the Board estimates that, shortly after the war, international passenger traffic, under American-flag operation, will increase at least six times, mail and express at least eight times

From the Standpoint of the Aircraft Industry: Preparations for post-war work have gone by the board, but experience in military construction has shown that 100-ton cargo planes are entirely possible. . . . They may not be in use tomorrow or even next year, but the manufacturers are doing something about them . . . For post-war continuance of operations, manufacturers of training planes will be in the forefront for making private planes; bomber and cargo ship builders will be in the driver's seat as far as passenger and freight liners are concerned . . . However, success in these fields will largely be determined by the government's action regarding excess military planes If thousands of training planes, bombers, and cargo planes are dumped on the market at a fraction of their cost, many manufacturers will be hard-put to weather the storm. . . On the other hand, if government decree is—as many of us hope—to maintain a large air force after the war, a certain amount of military manufacturing will be carried on and there will be little or no dumping of planes . . American manufacturers of large numbers of war-time cargo planes have one advantage in the international field: No other member of the United Nations is now building such equipment, and hence will not be in a position to compete in post-war markets . . Cost of manufacture is a factor that will bear close watching after the war Operations today are largely "regardless of cost" Later, they will have to be governed by the one element that today is disregarded.

More About Cargo Carrying: Intensive developments in military cargo planes will probably form the basis of post-war operations . Planes now available for huge military cargoes will be tailor-made for peace-time work Cargo planes will not necessarily all be large They will be built for specific services, the larger planes being used for long ranges where their greatest economy will be available. . While planes will not supplant other shipping methods, they will become invaluable adjuncts . . Cargo plane design will evolve as time goes on. Possible features of future ships will include high wing construction for convenience and safety on the ground; tricycle landing gear for level position of fuselage when being loaded, box-like cargo compartment with large loading doors, smoke detectors, and automatic fire extinguishing means

The foregoing constitutes a pre-selected bird's-eye view of the whole situation of aerial transportation, as it appears today from this vantage point Subject to change as technological developments dictate, and as governmental policies on the sale of materials, on taxation of the industry, and on the maintenance of adequate air fighting forces develop, it gives a basis on which to predicate future trends

RAMIE ON THE WAY

Textile development, urged on by war requirements, is bringing forward ramie, formerly obtained almost exclusively from China, but now being grown in Florida This fiber, subjected to scientific study and experiment, is now produced in extremely pliable form, soft, white, and silky. As formerly processed it was durable but not sufficiently flexible for many purposes. Although ramie fiber can be used alone, probable applications of it in the future will be as a blend with other fibers For example, it is stated that, mixed with wool, ramie gives better wearing qualities and prevents shrinkage when the fabric is laundered or soaked with water.

—*The Editors*

Two New Discoveries

A New Star, 100,000 Times as Bright as the Sun; and an Old Cometary Puzzle Solved

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

Two recent astronomical developments, though unrelated, may be described this month

The most notable, of course, is the appearance of a brilliant nova in the southern constellation, Puppis It appears to have been first noticed by Dawson, at Cordoba, Argentina, on the morning of November 9th, when it was a little fainter than the first magnitude During the next two days it increased in brightness, and was independently discovered by half a dozen or more astronomers—amateur and professional —before the news was sent out from the astronomers' "news center" at Harvard the next day Its maximum brightness, according to reports so far available, was about 0 4, surpassing Procyon and nearly equal to Rigel, then it faded rapidly, and at the time of writing it is barely, if at all, visible to the unaided eye

Had it appeared four months later, it would probably have been independently discovered by scores of people, but at the time of discovery it crossed the meridian at about 5:30 A M. by "war time" and rose above the haze of the horizon perhaps an hour and a half earlier, so that only early risers had a chance at it

It was well within the range of the great observatories, and spectra were promptly obtained They showed the characteristic wide emission bands, with unusually wide absorption lines to the violet, indicating that, as in other novae, an expanding shell or envelope of gas is moving outward from the star at velocities of the order of 1000 kilometers per second.

Lines of hydrogen, ionized iron, titanium, magnesium and silicon, and of neutral oxygen have been identified – which shows that we have to deal with an ordinary nova spectrum and not with the supernova type in which the wide bands have not yet been identified The rate of expansion, too, is moderate for a nova, and by itself does not indicate an outburst of exceptional violence. However, the actual luminosity at maximum must have been high, for the interstellar H and K lines of calcium are strong, indicating a great distance, which was provisionally estimated, at the University of Michigan, as 1600 light-years This is of the same order of magnitude as those which have been derived for other bright novae of recent years, and makes its absolute magnitude about −8 at maximum—corresponding to 100,000 times the light of the Sun

Before the outburst, this star was exceedingly faint. No trace of it has been found on plates taken with the great 24-inch camera of the Harvard Station at Bloemfontein, which, with an exposure of three hours, go down almost to the 18th magnitude It must then have been more than 17 magnitudes fainter than at maximum—that is, hardly more than one ten-millionth part as bright—and may have been fainter still. With the estimated distance, this gives a real brightness less than one percent of the Sun's, making it emphatically a dwarf star. Whether it was a white dwarf or an ordinary red one, we shall probably never know. But this huge increase in brightness is almost without precedent. Nevertheless, all the evidence, though still scanty at the time of writing, indicates that this is an ordinary nova, though a bright one

In due time, our knowledge of this nova should be detailed. It will be observable from northern latitudes for four months to come, and from southern observatories practically the year round, so that there should be no serious gaps in the record.

Meanwhile, we may consider a quite different, and rather puzzling, aspect of the general problem of novae. During the first half of the 20th Century—with eight years still to run—there have appeared seven novae which, at maximum, were of the second magnitude or brighter. Nova Persei of 1901 reached the magnitude 0.0; Nova Aquilae, 1918, rose to −1.4; Nova Cygni, 1920, to 1 5; Nova Pictoris, 1925, to 1.0, Nova Herculis, 1934, to 1 0; Nova Lacertae, 1936, to 2 2, and 1942 brings Nova Puppis of magnitude 0.4 This is at the rate of one nova in six years, or 16 per century. Yet during the whole 19th Century only two new stars were ever as bright as this—Nova Coronae Borealis of 1866, which reached the second magnitude, and Eta Carinae, which for some years about 1843 was brighter than Canopus and of magnitude −1. The latter, with its slow and irregular variations (it is now of the 8th magnitude) should not be regarded as in the same class as ordinary novae.

Three galactic supernovae are on record, Kepler's in Ophiuchus (1604), Tycho's in Cassiopeia (1572), and, brightest of all, the one in Taurus (1054) which formed the Crab Nebula All these appeared brighter than Jupiter, and far exceeded any fixed star Apart from these, the three brightest of recorded novae have all appeared within living memory and one of them is now fading in the skies

Not a single reliable record of a nova has come down from the 18th Century It might be argued (though with no great plausibility) that astronomers then were fewer and less on the watch But this explanation can hardly be applied to the 19th Century, when astronomers, though not so numerous as today, were much more used to looking directly at the skies, and had on the average a much better personal acquaintance with the constellations The suggestion that during the century a dozen or so temporary stars appeared, bright enough to be conspicuous to the most casual glance, and to change the familiar pattern of the constellation in which they were found, and that not one of them was noticed by professional astronomer, amateur or mariner—except one faintish object in 1866—is quite unbelievable. It is hard to escape the conclusion that the reason why no novae of the first magnitude were observed in the last century is because none were visible.

There is of course a possibility that a bright nova appeared in some part of the sky which was close to the Sun at the time, and faded out before this region got clear of the dawn. This almost happened, in fact, for the supernova of 1054. But the list of 20th Century novae includes those actually observed and would be equally subject to such vicissitudes.

It seems, therefore, that the accumu-

lation of bright novae in the first part of the present century is merely a matter of chance. It would be hard to think of any phenomenon that could be more certainly trusted to be "at random" than the appearance of a nova. The actual outbursts of the stars take place in regions of space hundreds of light-years apart, and it is almost inconceivable that one could influence another. Moreover, we record, not the time of the catastrophe, but the time when we saw it, after many centuries of light-travel. Observers 50 light-years from the Earth—only a small fraction of the distance of the novae—would see some of them 50 years earlier than we, and others 50 years later, and the order of their appearances, and the bunching of these in time, would be very different.

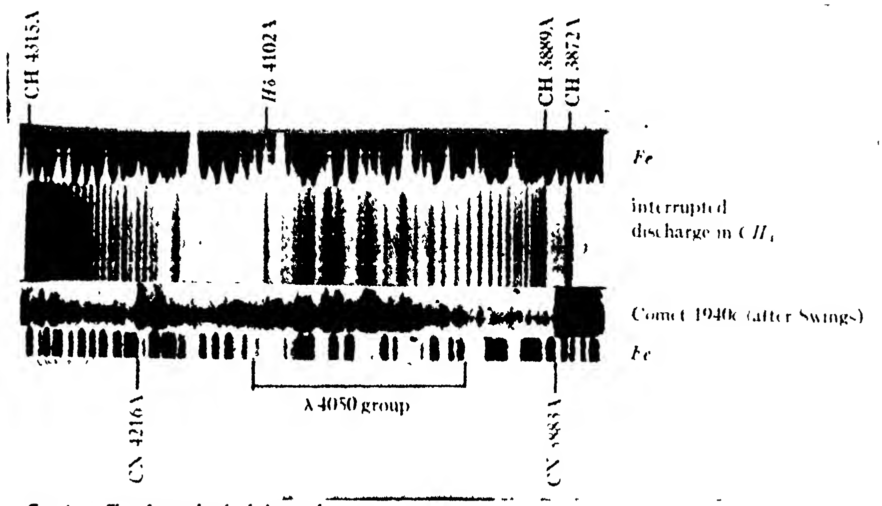
We can not be sure, however, whether the dearth of novae in the 19th Century, or the plethora in the 20th, is more nearly representative of the general average. If they keep on appearing at the same average rate for the next 40 years or so, our successors may shift to the view that the queer run of luck happened in the 19th Century.

Or perhaps they may turn to the principle familiar to every lawyer, that the testimony of many trustworthy witnesses who swear that they didn't see something, does not count against that of one trustworthy man who swears that he did, unless it can be *proved* that the first lot of folks were looking the right way!

Coming back to the solar system, we may note a second important discovery—one regarding the spectra of comets.

Most of the bright lines and bands in cometary spectra have been identified, and arise from compounds of the familiar light elements, C_2, CH, CN, NH, OH, and so on—all molecules composed of two atoms only—fragments of the molecules familiar in the chemical laboratory, which are partly but not completely dissociated or decomposed, probably by the action of very short-wave ultra-violet light from the Sun. One group of bands, composed of lines so closely packed that each group looked like a wide line, in the vicinity of 4050A, has defied identification.

Swings, comparing the spectra of comets at different distances from the Sun, found that, for those outside the orbit of Mars, the unknown bands were strong, and the well known bands of CH at λ4313 were very weak. At the Earth's distances, the former are about the same, but the latter stronger; at



Courtesy The Astrophysical Journal

Comparison of two spectra, the upper that from a laboratory experiment by Herzberg, the lower that of a typical comet

Venus' distance, the two are equal, and, for a comet observed inside Mercury's orbit, the unknown bands were very weak and the others strong.

The strengthening of the CH bands, which are known to be produced by a product of dissociation, as the intensity of the sunlight increases, is easy to understand, while the weakening of the 4050 group suggests that they may be produced by some substance which tends to be decomposed by the more intense radiation.

Following this clue, Herzberg, of the University of Saskatchewan, showed that the structure of the bands is what might be expected in the spectrum of a molecule containing not two, but three, atoms (provided that the three are nearly, but not quite, in a straight line). From the close spacing of the bands, it followed that this molecule had a very small moment of inertia—which would be possible only if the two outer atoms were hydrogen. This reasoning suggested that the molecules might be CH_2. To settle the question, it was necessary to produce the spectrum of this molecule in the laboratory—and here Dr. Herzberg's well-known skill has scored again. The obvious suggestion was to use methane gas, CH_4, but, on introducing this into an ordinary vacuum tube, only the spectra of atomic and molecular hydrogen were obtained with faint bands of CH. Evidently the methane molecules were being so badly abused by the discharge that they quite fell apart, leaving only a few in the last stage preceding complete decomposition. It was noticed, however, that immediately after turning on the discharge the light emitted was of a bluish-white color, which soon turned pinkish. This suggested using a tube through which the methane was streaming continuously—flowing in at one end and pumped out at the other—and turning the discharge on for a fraction of a second every few seconds. The spectrum of such an interrupted discharge showed a new group of bands, which proved to be identical in detail with the λ4050 group observed in comets.

It is evident that this spectrum must be emitted by methane or one of its decomposition products CH_4, CH_3, or CH_2. From the conditions of its production, it is probable that it comes from the last of these stages. The question can be settled by a detailed analysis of the structure of the bands—resolving them into separate lines by a powerful spectroscope—and Herzberg reports that this investigation is now under way.

The last important puzzle in cometary spectra is thus cleared up. Its solution presents a fine example of the combination of results obtained in quite different ways. The astronomer, observing the faint light of comets with spectroscopes especially designed to be powerful enough to get results, but not so powerful that they would be unable to get a developable image in the available exposure time, discovered the relation between the intensity of the bands and the comet's distance from the Sun. The theoretical physicist, employing the intricate theory of the spectra of polyatomic molecules, found that the cometary bands probably arose from a molecule of three atoms, two of which were hydrogen. Being also a first-rate laboratory spectroscopist, he devised conditions in which just these partially dissociated molecules were present in large numbers in his tube, observed their spectra, and completed the proof.—*Princeton University Observatory, December 4, 1942.*

Celestial Navigation

A Specimen of the Kind of Studies which the Youth of the Marine and Air Services are now Pursuing

E. B. COLLINS
Nautical Scientist,
Hydrographic Department, Navy Department

TODAY, the anxious plight of a war-torn world calls for the supreme effort from every qualified navigator to aid in the safe guidance of our loaded surface ships over the uncertain waters of the world's seven seas, and, in addition, the shaping of courses for aircraft on long-range combat flights above or below the clouds.

The strenuous war program necessitates an extremely simple and elementary method for the rapid training of hundreds of youthful navigators This calls for practical, simple, and uninvolved instruction.

The principles of celestial navigation are based on the science of nautical astronomy, but young mariners need not be astronomers, though they must become familiar with certain technical terms, also with the general nature of the universe with which they deal.

Therefore the beginner is concerned only with two revolving spheres, the rotating earth turning eastward on its axis, and the great celestial dome of stars, rotating on the same axis extended and appearing, because of the earth's eastward rotation, to turn westward around the earth.

Vertically over the navigator's head on this celestial dome is his zenith All points directly over other points on the earth's surface are the zeniths of those points. The geographical position, then, of any heavenly body with relation to the earth is a point on its surface that has the celestial body in its zenith. This point is determined by its co-ordinate of latitude, which is equal to the declination of the body, and its other co-ordinate of longitude, which is equal to the Greenwich hour angle of the body. All co-ordinates for any heavenly body seen at any given instant of Greenwich meridian time are recorded with respect to the equinoctial in the seaman's Nautical Almanac issued annually by the United States Naval Observatory, at Washington.

The mariner at sea invariably deals directly with objects seen on or above his horizon, and with imaginary circles passing through his zenith, called vertical circles. The azimuth, or true bearing of a celestial body in the sky, is the angle at his zenith measured by an arc of the horizon between his meridian and the vertical circle passing through the sun or star The true altitude is the angular distance in arc from the plane of the horizon, measured on a vertical circle passing through the body from 0° to 90°. From this it follows that the zenith distance is the angular distance from his zenith, and is equal to the complement of the altitude Thus it is seen that the position of a heavenly body with relation to the horizon is given by its altitude and by its true bearing, or azimuth.

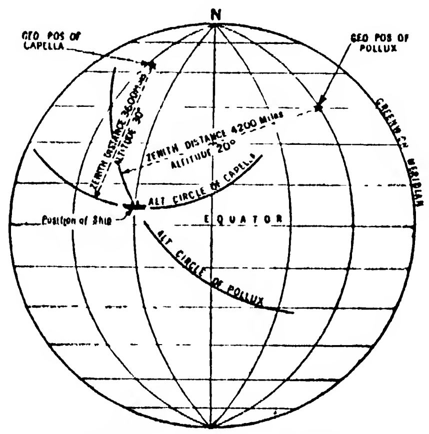


Figure 1: **Intersecting circles**

IT IS well here to explain in a general way to those who are not navigators what the real problem is that confronts the young navigator. Observations, or "sights," of sun, moon, or star, taken by a mariner with marine sextant, or bubble octant, consist in the measurement of arc of altitude of that body above the horizon (azimuth cannot yet be accurately measured). What that observation gives is, in effect, the zenith distance of the body for some specified instant of Greenwich time as shown by the navigator's watch, whose error is always known from daily comparisons made with radio time signals received at the ship from stations on shore, a routine procedure at all times.

The data then obtained from his Nautical Almanac for this observation are the celestial body's co-ordinates of declination, or the body's angular distance north or south of the Equator or equinoctial; and its other co-ordinates, the Greenwich hour angle, or angular distance of the body away from the prime meridian. In other words, it is the longitude measured westward from the initial meridian of Greenwich, England. This enables a point on the earth's surface, which has the body in its zenith, to be readily plotted on a globe, or on the mariner's marine chart. This point is called the subsolar point in case of the sun, the sublunar point in case of the moon, and the substellar point in case of star or planet. It is generally known as the heavenly body's geographical position and is plotted on the earth by its co-ordinate of latitude (declination) and its co-ordinate of longitude (Greenwich hour angle).

AS PREVIOUSLY stated, the "sight" for altitude gives the true zenith distance of the body observed, or the angular length of a radius from the celestial body to the navigator's zenith. If, now, a small circle be drawn on the earth's surface, having its center at the body's geographical position and with its angular radius equal to the body's zenith distance, then the navigator knows that he must be located at some point on this small circle on which all measured altitudes of this celestial body, wherever on the entire earth's surface these measured altitudes are found to be, are the same at this chosen instant of Greenwich Civil Time.

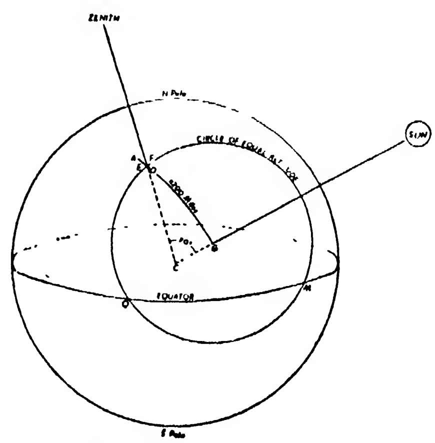


Figure 2: **Practical example**

If, now, *two* observations of a body are taken at different intervals of time, or if two different bodies are observed at the same instant of time, then two circles of altitude may be drawn. These

circles will, of course, intersect in two points. The one selected is the point nearest to the navigator's estimated locality, or what is known as his dead reckoning position (Figure 1).

As a practical illustration, suppose a sight of the sun is observed and the altitude measured with sextant as 20° above the horizon, thus giving a zenith distance of 70°. In Figure 2, let *G* be a place on the earth's surface at which the sun is vertically overhead at the moment of observation. Then this one observation shows the navigator to be at a distance *G* of 70° x 60 (each degree of zenith distance corresponds to 60 nautical miles). Therefore, he must be somewhere on the circumference of the small circle *DMQ*, the center of which is *G*, and the radius 4200 nautical miles, and he may be presumed to be on that portion of the circumference which passes near his dead reckoning position. Let *A* be any assumed point on some integral degree of latitude near the navigator's estimated position. He then also assumes a longitude, or, what is equivalent, he assumes a local hour angle from his own meridian and then proceeds to solve the spherical astronomical triangle *PMZ* shown in Figure 3.

To arrive at his solution by this method, the old-time navigator usually required some 20 minutes or more, because a long, nerve-trying process was used, employing many logarithms, to

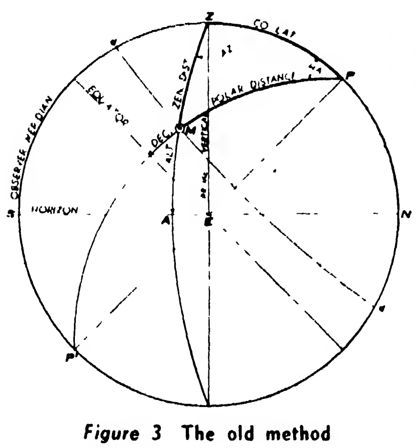


***Figure 3* The old method**

find the value of the latitude and azimuth of this heavenly body at his approximate position. In those earlier days of marine navigation, when all the sights were computed by a lengthy logarithmic process utilizing many numerical figures in the solution of the astronomical triangle, there was a large chance for the occurrence of many mathematical errors. But the navigator of today shoots his sight at any time of day or night and works every observation with the same uniform process to give him the line of position without all that complexity.

Now, in a simpler method, suppose, in Figure 2, that the zenith distance at *A* is computed and found to be 70°10′, and at the same time the sun's azimuth is computed and found to be 135° from north. Then *GA* equals 4,210 miles and *AD* equals 10 miles in the direction 135°. That is, *AD* is the difference between the true zenith distance as found from the observation sextant and the computed zenith distance as found from the astronomical triangle *PMZ*.

Figure 4 shows how the arc *AD* and the arc *EF* of the circle of equal altitude is laid down on the mariner's large-scale working chart. Since these two arcs are extremely short in comparison to their long radii, they will be, for all practical purposes, straight lines. We then lay off from *A* a straight

Official U. S. Navy Photo
Taking a sight of the sun

line *AD*, known as the altitude intercept, representing 10 miles—the difference in minutes of arc between the true measured altitude and the computed one—and in the direction 135° toward the sun, (since the true altitude is greater, but away from the sun, if the true altitude were the less) and through *D* we draw *EF* perpendicular to *AD*. Then *EDF* will represent a small portion of a circle of equal altitude, or what is known as the navigator's "line of position," and the crossing of two lines of position will determine the "fix" of the ship, or its geographical position on the earth.

It is evident that if the solution of all the different cases enumerated above are correctly tabulated for altitude and azimuth in a set of convenient tables, then the navigator need make no more mathematical calculations, for he can now solve his observation by inspection of these tables in less than four minutes of time, with no arithmetical errors creeping into the result.

The Hydrographic Office of the Navy has selected just such a simple process for all navigators to use, and this system is taught to all young navigators, for it is believed to be the best, the fastest, and most fool-proof method yet devised. This is because

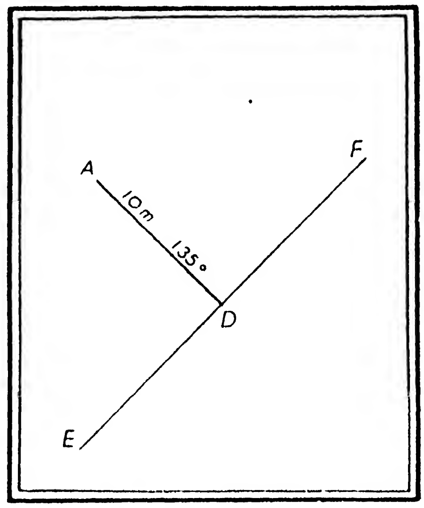


***Figure 4:* The actual layout**

every "sight" is handled in the same simple, uniform manner.

No doubt the ideal tables for any navigator with no fondness for mathematical calculations is one with ***no interpolation***, but the maker, or designers, of short navigational tables soon encountered three independent variables in every spherical triangle solved, and allowing for combinations for each minute of arc from 0° to 90°, it was noted that the preparation of such tables would involve tabulating the solution of 90' x 60' or 157,464,000,000 separate spherical triangles which, at the rate of 1000 triangles computed a day, would take some 400,000 years to compute and complete. Tables of such voluminous proportion being entirely out of the question, the Hydrographic Office was completely satisfied with obtaining values for three variables cut down to the nearest integral degree of latitude, and each degree of hour angle with an ingenious scheme utilized for correcting for any odd minutes of declination. These numerous computed values were neatly tabulated and clearly printed in nine flexible volumes containing belts of 10° of latitude, from the equator to the north or south poles, and entitled "Tables of Computed Altitudes and Azimuth." Each book contains 264 pages, or about 2400 pages for the entire set of tables, and involves the solution of over 10,000,000 separate spherical triangles.

Something That's Getting Better

Not Wars, not Taxes, but Public Health. Summarized Improvements of a Quarter Century are Startling

● That medicine in our times is making vast strides is a commonplace—too commonplace, in fact, since many of us cannot keep up with its advances. Thus it could come about that an overall reckoning at the end of a given period of years might take us by surprise, exceeding our most optimistic impressions. This is how such a reckoning, published in the monthly *Statistical Bulletin* of the Metropolitan Life Insurance Company, struck the editors of Scientific American—even better than they would have dared claim. Note especially the table below.

For giving prominence to the statements of a private organization, as is done here, no apology need be offered, since many such organizations do scientific research having the same standing as that done at universities. Besides, where else than the large insurance companies can such current statistics be found? These statistics form a most valuable complement to the official statistics on the nation's health. The Metropolitan Life Insurance Company, in one of its departments alone, covers 16½ million policyholders, regarding whom it has detailed statistics, and these 16½ million industrial policyholders constitute a very large sample of the wage-earning part of our population—*The Editors* ●

THE health of the American people is bound to play an all-important role in the present war. On it depends the maintenance of high morale not only in the armed forces of the nation, but in the civilian population as well. The workers on defense projects cannot be expected to accomplish successfully the great job that still lies ahead if they are not kept well and physically fit.

Fortunately, the country was never better fortified in point of health than today. Thanks to the succession of outstanding discoveries in medical science and notable developments in public health, we are now much better prepared for the hardships and vicissitudes of modern warfare than we were 25 years ago at our entry into the first World War.

This is clearly shown in the mortality experience among the industrial policyholders of the Metropolitan Life Insurance Company. Their death rate in the age group one to 74, adjusted for changes in color, sex, and age distribution, has been reduced slightly more than 50 percent in the course of the last quarter of a century. In this reduction in the general mortality the death rate from practically every important cause of death individually took part, as shown in the accompanying table of standardized death rates per 100,000 persons.

CAUSE OF DEATH	1941	1917
ALL CAUSES—TOTAL	615.5	1264.5
Typhoid fever	0.4	12.0
Measles	0.8	10.2
Scarlet fever	0.5	5.4
Whooping cough	0.7	5.0
Diphtheria	0.7	21.7
Influenza	5.9	15.0
Pneumonia—all forms	23.0	131.8
Tuberculosis—all forms	40.9	202.2
Syphilis	9.1	19.1
Cancer—all forms	84.5	80.7
Diabetes mellitus	19.6	17.1
Chronic cardiovascular-renal diseases	262.8	373.2
Diarrhea and enteritis	2.0	24.6
Appendicitis	7.2	11.6
Puerperal state—total	4.6	17.2
Accidents—total (excluding war deaths)	50.0	84.3
Automobile accidents	20.4	10.0

The diseases of childhood and infancy—measles, scarlet fever, whooping cough, diphtheria, and diarrhea and enteritis—have been virtually eliminated as causes of death within this period. This means not only that there has been a very substantial saving of life at these early ages, but that many of our young people living today have been spared the disabling sequelae of these diseases. In consequence of this situation, thousands are now available for war service who, under former conditions, would have been rejected.

The death rate from tuberculosis among the industrial policyholders has been reduced to just about one fifth since 1917. This is a fact of particular importance in connection with the war effort, because tuberculosis finds many of its victims among those in the prime of life—that is, between the ages of 20 and 50—the very people on whom fall the chief burden of prosecuting the war.

Syphilis is another disease concentrated mainly in youth and middle life, that unfortunately tends to spread in times of war. The mortality from syphilis among the Company's industrial policyholders is less than half of what it was in 1917, and the outlook for its control in this war is much better than it was 25 years ago.

Calamitous in the last war were our losses from influenza and pneumonia. The first of these fluctuates so widely in prevalence and virulence from year to year that it is impossible to estimate the likelihood of a serious visitation within the next few years. Recent research into the causative agent of influenza, however, encourages the expectation that the nation may be better prepared today to cope with any epidemic that might arise than it was in 1918. Pneumonia, thanks to the new chemotherapy, has lost much of its former terror. The death rate from this cause among industrial policyholders has dropped more than 82 percent since 1917.

IN VIEW of the rapidly increasing industrialization of the nation and the fact that many defense workers are for the first time coming in contact with machinery and other hazards of war work, we can hardly hope to escape an increase in fatal accidents. But during the years since 1917 there have been such marked advances in industrial hygiene and in accident prevention, that many lives and countless working days are being saved that would have been lost under the working conditions prevailing at the time of the last war.

A factor that is not without influence in maintaining morale is the marked improvement recently experienced in the mortality of women in childbirth. It is a comfort for the young father, whether in defense work or in the

armed services, to know that modern care available to his wife during her pregnancy and confinement has greatly diminished the risks to which she is exposed at that critical time. In this he can have better ground for confidence than had his father during the first World War. Improvement in prenatal care, obstetrics, and hospital facilities since 1917 have achieved wonders in reducing the hazards of the puerperal state. Whereas 25 years ago more than 17 out of every 100,000 of the Company's industrial policyholders died in childbirth, today this rate is reduced to five While some part of the decline is due to the reduced birth rate during the period under study, much the greater part unquestionably is attributable to better medical and nursing care.

Such are some of the changes in mortality from certain of the principal causes among persons in the more active ages of life Less directly related to the war effort are the causes of death characteristic of the declining years, including more particularly chronic degenerative orders As a matter of fact, even among these there has been considerable improvement since 1917.

Inasmuch as the Company's policyholders number many millions and are distributed widely in all sections of the country, they constitute a very representative cross-section of the total wage-earning population Their health experience since the last war, therefore, reflects closely that of the entire country, and the observations here recorded on the basis of their experience may be considered generally applicable to the nation as a whole.

• • •

PROGNOSTICATION

Modern Living Will Make Us a Myopic Nation

America is becoming a near-sighted nation. Each decade more and more of the population are near-sighted.

The steady movement of the American population toward near-sightedness, some ophthalmic experts assert, is caused by two factors—modern living conditions, wherein man has changed from a far-looking to a near-looking creature, and heredity. Near-sightedness is a physical characteristic that apparently is handed down by parents to their children.

Mankind for thousands of years spent much of the time out of doors and the human eye developed so that normally it is at rest when gazing at a distance, but hard at work when focusing on near objects Within the past century education has become almost universal and children start reading at an early age. There are relatively few of the adult population who do not spend many hours each week in reading newspapers, magazines, and books—all hard work for the eyes Men and women increasingly have moved into indoor occupations, operating machines and carrying on clerical activities—most of which require close focusing Human eyes are becoming near-sighted in order to meet these new conditions of modern living requiring sustained close vision

• • •

RECOVERY—Nearly half a minute is required for average eyes to recover fully from exposure to bright, glaring light, according to tests made at the University of California.

• • •

STUTTERING

Believed a Case of "Mind-and-Body"

According to *The Journal of the American Medical Association*, stammering (stuttering) is a somatic manifestation of an emotional disorder based on a psychobiologic variation of the organism

As yet there is doubt as to the exact mechanism that underlies this variation, but evidence strongly suggests the presence of an inherited constitutional factor which predisposes to emotional instability and psychomotor disorganization in general and to stuttering speech in particular.

However, a person's inherent psychosomatic deficiencies would not in themselves cause stuttering speech without some active precipitating factor: shock, cumulative environmental pressure, radical change of environment or, as in the instance cited, acute or prolonged illness.

There are two stages in the development of stuttering, primary and secondary. The chances of arresting the disorder are much greater in this first stage, before anxiety and inferiority feelings begin to develop and before conditioning has had time to operate In the primary stage, therapy is largely a matter of slowing down the tempo of living and removing any exciting stimuli in the home environment, particularly the excitement and tensions generated by neurotic parents. Family quarrels, exciting games, rapid speech or other "nervous" reaction patterns on the part of parents or older children should be eliminated. The child should be kept in as good a physical condition as possible, he should have frequent periods of rest and relaxation, and fatigue should be avoided. Also, since the stuttering child demonstrates in general a lowered degree of psychomotor efficiency, especially in those functions requiring fine coördination, a certain amount of rhythmic work is recommended games and simple exercises in time to music, marching to the beat of a toy drum, bouncing a ball in rhythm, and the like He should be encouraged to do everything, speaking included, slowly and easily Games in which the whole family participates can be devised to inculcate the idea of slow, easy, rhythmic activity

With regard to the stuttering symptom itself, the parents should avoid correcting the child's speech directly, since this may make him speech conscious and precipitate the second stage of the disorder. A tactful suggestion —"Let's all try to talk slowly and easily; I don't hear so well today"—will usually produce better results than making a child repeat a specific word or phrase with which he has had difficulty The parents should also avoid the all too common habit of interrupting the child when he stutters, talking for him when he is having difficulty or suggesting some "tool"—taking a deep breath, for instance—to help him over the blockage Such tactics serve only to arouse his awareness of his difficulty and to develop anxiety and feelings of inadequacy If possible the child should not be allowed to suspect that the physician or parent is concerned about his speech, or that it is in any way abnormal.

SHAKE HANDS

Hands Unimportant in Spread of 'Flu

Discovery that the influenza viruses type A and type B die in a few minutes, if put on human skin, such as the palm of the hand, and allowed to dry there, has been made by Commander Albert Paul Krueger, in command of Naval Laboratory Research Unit No. 1 at the University of California

"Virus solutions so strong that a teaspoonful would kill half a billion mice, lost all disease-producing capacity within 10 minutes," Commander Krueger, formerly professor of bacteriology at the university, stated. "Hand to hand distribution of the virus and eventual hand to mouth transfer would appear to be unimportant hazards."—*Science Service.*

'Commercial Sound' Enlists

The Microphone and the Loudspeaker Join in the War Effort to Increase Efficiency of Operations

GEORGE R. EWALD
Manager, Sound Products Division, RCA Manufacturing Company

The rapid transition to wartime activities throughout this country has brought about many startling changes. Evolution that would ordinarily occur slowly over a number of years now takes place almost over night. New ideas, new processes, new materials, and new man-to-man relationships are rapidly taking form in industrial operations. These changes create new needs and, as is usual in periods of flux, the inventive genius of man responds to the urgent necessities of the occasion.

One of the most interesting developments has occurred in the field of what has been somewhat loosely termed "Commercial Sound." Certainly, the word "Commercial" does not now properly classify the tremendously broad field into which amplified sound has made its entrance so effectively. Today the microphone, amplifier, and loudspeaker are vitally necessary adjuncts to the efficient operation of industrial plants of every description; military projects of all kinds; air fields; naval bases; ordnance plants; proving grounds; training schools; shipyards and railroad yards; amusement, educational, and recreational activities; and, in fact, in any inside or outside location where it becomes necessary to convey sound intelligibly to groups of people or over distances where unamplified sound will not serve the purpose.

Commercial Sound has served a fearful as well as a useful purpose. It is indeed doubtful if Hitler's hordes would now be over-running Europe, Asia, and Africa if he had not been able to exercise his almost hypnotic control over millions of people through the use of loudspeakers.

On the other side of the picture, however, the use of amplified sound has become a tremendously important factor in the expediting of production; the improvement of efficiency in organization operation; a most potent time-saver in locating key men in every nook and corner of our great factories; and has tremendously reduced loss of life and damage to property in emergencies. So, a microphone is now found at the elbow of every man who desires to accomplish things quickly and efficiently, and millions of loudspeakers are in use throughout the world, in every place where people gather either for business or pleasure.

Control desk for handling "commercial sound" calls

Originally, when it was found possible to satisfactorily amplify sound and project it for some distance, the field of entertainment seemed to be the most natural development for the use of loudspeakers. As this use grew and developed, the possibilities for educational purposes became apparent, and it was not long before the schools and colleges throughout the country were equipping their auditoriums, laboratories, and individual classrooms with this most useful device. Slowly and gradually the amplifier found a place in various types of business establishments, although at the beginning it was curtailed in most places to the use of intercommunication equipment.

It has only been within the last 24 months that the real possibilities of the amplification of sound in great industrial establishments were realized. This development has proceeded with such tremendous impetus, however, that interesting and even spectacular incidents illustrating the value of sound equipment are developing daily, and the story surrounding the use of such equipment is worth telling.

Perhaps the best description of the varied use of sound equipment in industrial operations can be given by citing specific reports that are now available from many plants that are engaged in full wartime production. Many of the giant buildings that have recently been erected to house production of military equipment cover great areas of ground with immense rooms, unbroken by walls or partitions. Rapid man-to-man contact is difficult because of the tremendous distances and numbers of people involved. Buzzer or horn signaling in code, and the telephone and inter-departmental memo have been tried, but, due to the limitations of time and space, contact has been slow and much valuable supervisory time wasted trying to locate people wanted for quick answers.

Paging executives and key men has now become a fast and efficient process through the use of plant-wide sound systems, and it is interesting to note some of the comments that have been made regarding the actual efficiency in operation achieved in this way. A letter received from one of the big aircraft companies contains the following significant sentence: "To indicate the importance of these sound systems in our plant, it is interesting to note that our main plants make approximately 1500 calls each per day, with the smaller departmental systems making approximately 250 calls each per day, making the total calls of all systems about 6000 per day."

From another large Eastern industrial plant comes this statement: "We also find that our maintenance work is greatly expedited by our ability to reach the maintenance crews and give

them orders immediately, no matter where they may be in the plant."

Through the proper installation and use of a sound system the load can be taken off the existing telephone lines The necessity for new lines is thereby obviated, as well as additional switchboard personnel and telephone lines involved for intra-office and plant use.

A plant manager speaks in the following terse but effective words. "The primary function of our sound system is paging This averages 1000 calls per day It is estimated that five minutes time is saved on each call, or a total of approximately 80 man hours per day"

Many speakers suspended from ceiling bring music to workers engaged on precision jobs

Hundreds of similar quotations could be produced, emphasizing the increased efficiency in operation that comes with procedure controlled by means of industrial loudspeaker equipment What could be more convincing than this excerpt quoted from a letter received from a superintendent of a big steel mill · "The RCA sound equipment in our mill has been in operation approximately one and one half years I feel that since this installation has been made, 95 percent of the mistakes formerly made, due to errors in signaling from the heaters to the rollers, have been eliminated"

The modern industrial plant today is subject to many stoppages of work due to emergencies of various kinds Fortunately, air raid warnings so far have been entirely a matter of test procedure Undoubtedly these tests will save lives if hostile airplanes finally should be able to break through our defenses. The quick control of thousands of people, and the proper instructions for the guidance of these

Portable sound equipment for playing music, and public announcements

people, can only be made possible through the use of sound equipment. There are also other emergencies due to fires, explosions, power breaks, and other unusual happenings Centralized sound equipment provides the best and safest answer to the proper control and handling of such emergencies It has proved its worth many times in actual installations

Military projects of every kind are now using sound equipment for many purposes. In camp, where trained buglers are not always available, the stirring strains of reveille are played over the loudspeaker from a record made for that purpose. Field maneuvers can be directed over wide areas through the use of mobile equipment, and in a number of large camps the entire camp has been sectionalized and covered with sound equipment so that the camp commander can address the entire personnel of the camp, or the various unit commanders can handle their separate sections individually.

Sound equipment is indispensable at the large air fields, and an interesting development of this use is the ability to control instantly with one emergency switch the entire system for such purposes as direction of personnel in the case of crash landings, or other emergencies of a similar nature.

The amplification of recorded music and the distribution of this music throughout large industrial plants has attracted much attention recently. It is estimated that about 3000 factories in the United States are now using music for this purpose, and many interesting data have been compiled as a result of this use. [An article on this specialized phase will be published shortly in these pages —*Editor*]

Schedules have been worked out showing the type of music and the proper times during the day at which these programs should be heard At many plants during the lunch hour news commentators and other current programs are reproduced over the sound system, and quick-step marches are often played as the workers assemble or leave

A number of broadcasting stations are now reproducing musical programs for the benefit of workers on the night shifts. Apparently the day is fast approaching when national advertisers will seize the opportunity now afforded through the reproduction of programs of this sort to thousands of industrial workers throughout the nation.

Safety talks and messages can be broadcast regularly to all employees, and large insurance companies are now devoting a great deal of study and attention to the possibilities afforded in this way of emphasizing safety precautions and improved health habits.

Cordial co-operation between management and labor is a tremendously important factor in the speeding up of war activities, and the Government has given its stamp of approval to campaigns based on building morale and the improvement of employer-employee relationship. These campaigns are largely based on mass meetings of employees and the broadcasting of

speeches, songs, talks by men in the armed services, and top Government officials Obviously, such programs are impossible without the use of plant-wide sound systems, and the personnel directors in the large companies are quick to seize upon this method of stepping up morale

CAMPAIGNS designed to stimulate productive activities are efficiently carried on through the use of sound systems, and even though plants are thousands of miles apart, officials can participate and be simultaneously heard in all plants The quotation below, which was contained in a letter received from the superintendent of one of the big United States ordnance plants, summarizes the value of sound equipment as effectively as can be imagined. He says "With this installation it was possible for us in the average time of 120 seconds to reach the many officials, contractors, foremen, and other individuals who were moving about the two and one-half square miles of territory comprising this project. It was also possible for us to give instructions to all the thousands of employes at work on this project at one time while work was in progress On one occasion we assembled 8000 workmen on 20 minutes' notice who could have been reached by no other method Our ability to contact individuals or groups of people has materially speeded construction and has saved thousands of dollars through increased efficiency"

The progress and development in the use of sound systems which has proved of such great importance in this period of wartime activities is certainly only the forerunner of even greater and more widespread development in the years to come There are vast fields of activity that have hardly been touched up to the present time

Sound equipment has been installed in a few railroad yards and the actual use in these yards has already demonstrated the possibilities of time and labor saving in every type of railroad operation. Here, certainly, is a tremendous field to be developed, and one that will pay large dividends.

Already sound installation is playing an important part in the great inland waterways of this country. On both lake and river, tug boats and tow boats are working day and night moving great accumulations of freight by water. Many times the pilot or navigator is hampered by poor visibility and great distances between his location and the various barges or other bottoms he is handling. The lookout at the microphone stationed at the bow or stern of his fleet helps materially in the safe and efficient passage of these cumbersome craft through the water.

Shipyards cover vast outdoor areas, and here the problem of communication is particularly difficult. Practically every large shipyard in this country is now wired for sound, and the flexibility of this equipment permits it to be used in the remotest corners and even on board the ships under construction

Complete intercommunication between all important desks in the large offices and warehouses not only facilitates the dispatch of all ordinary business, but actually is a great money saver in decreasing the number of telephone units in use, and in relieving the ever-present load on switchboard facilities.

LOOKING into the future, it seems safe to predict that the up-to-date architect will provide all future buildings, whether they be for business or residential purposes, with completely integrated sound systems Outlets for sound will be provided just as outlets for electricity are arranged, and it will be comparatively simple and inexpensive to connect speakers to these centralized systems as the occasion requires. The housewife in the modern home will save countless steps and time, as she can sit in her bedroom or living room and talk to salesmen at the front door, or converse with the maid in the nursery or the cook in the kitchen In the more elaborate homes, she, of course, can direct her instructions to the servants' quarters or to the chauffeur in the garage Speakers in each room will be switched on and off as desired for the reproduction of radio or recorded programs from a centralized control station These speakers, of course, can be recessed behind attractive grills in the original construction of the house and thus prevent any unsightly accumulation of individual baffles and wires

Amplified sound is destined to play such an important part in our daily lives in the future that probably twenty years from now it will seem impossible to believe that we could have gotten along without it. It will have its recognized place in the home, office, and factory, just as electric lights, running water, heat, and refrigeration now do

In many ways that cannot be told now, sound equipment has enlisted for the duration. This same equipment that is now helping to win the war will emerge in the post-war era in the form of finer and more adaptable equipment, its value and usefulness better understood.

• • •

HEADS

Are Sculptured to Furnish Mask Models

WITH the permission of the War Department, Orr Goodson, acting director of Field Museum of Natural History, Chicago, recently revealed a unique activity, in which the museum has been engaged for some months past, that contributes to the safety of members of the United States Army Air Forces.

The museum (of all places!) is now a producer of an important war accessory. This is the result of combined application of the scientifically accurate measuring methods (anthropometry) used by physical anthropologists to gage distinctive characteristics of groups of men and women; the researches of medical officers attached to the Army Air Forces; the art of the sculptor in depicting human types; and the driving force of experts in military efficiency and in manufacturing methods to obtain production and action with speed and precision.

For flying in high altitudes, the pilots, bombardiers, gunners, radio operators, and other men of the skies require oxygen masks, and these must be accurately fitted to each man's head In an anthropometric survey of 2000 fliers, conducted by officers of the Army's Aero-Medical Research Laboratory at Wright Field, Dayton, Ohio, it was found that the shapes and sizes of aviators' heads could be reduced to seven basic composite types from among which the fliers could be properly fitted with masks. One of these head types—labeled as No. 1, "the mean" (in the sense of average) type—corresponds to the fitting requirements of the majority of the fliers, the other six head types represent the extremes of contours and out-sizes in all directions. The head models give the manufacturers of masks and headgear guidance in their production of the variations required, and the quantities of each size as needed.

After the original master set of sculptured head models, based on the measurements furnished by aero-medical officers, had been approved by Army authorities, the problem arose of producing sets of these models in quantity, as the heads, to meet the medical and air-safety standards, have to be micrometer-accurate.

Because of the scientific nature of

Drs. Zworykin and Hillyer, of RCA, with the new portable electron microscope

this project, the services of the museum laboratories and technicians were enlisted; production of accurate molds, and from them of accurate plaster casts of the sets of aviators' head types in accordance with the specifications of the aero-medical officers, is consequently now well under way at the museum

• • •

SALT—One vital war material which will never need to be rationed to consumers is salt. The United States has inexhaustible supplies, including the world's largest salt mine, the International Salt Company mine in New York, which covers 1000 acres, has 120 miles of passageways and goes to a depth of 1073 feet.

• • •

SOUVENIRS

Should Not be Collected After Air Raids

ADMITTING that the tendency to collect "souvenirs" is a natural one, James M. Landis, Director of the Office of Civilian Defense, cautions that in case of an air raid on this country the gathering of bomb fragments and other mementoes may deprive the armed forces of vital information.

Objects of particular value for the information they convey include grounded enemy planes or parts of planes, personal equipment, weapons, and projectiles dropped or lost by the enemy, it is pointed out.

Any such objects found should be left in place and guarded until civilian defense authorities have been notified and an OCD technical assistant or a military representative has made an investigation. The location of the object, its position, and the degree or lack of penetration may be of great importance.

SKIS

Produced Rapidly By New Resin Process

BECAUSE the United States army needed skis in a hurry, the Allied Aviation Corporation of Baltimore started research work. Operating with the Vidal process, wood is bonded with synthetics, placed on forms, and covered with a rubber blanket and heater, using the pressure tank method. The process not only forms the skis but stabilizes the wood against warpage caused by changes in humidity, temperature, or contact with water· extra hardness and durability also result. Neither boiling water nor sub-zero weather will seperate the layers of wood, and it is not necessary to keep the skis in clamps to hold their shape when not in use.

PORTABLE

Electron Microscope Widens Its Field of Usefulness

A NEW electron microscope, small enough and inexpensive enough to be available to hundreds of medical, university, and industrial research institutions, has been developed by RCA Laboratories, Dr. V. K. Zworykin, Associate Director of the Laboratories and Contributing Editor to Scientific American, announced recently.

Only 16 inches long and light enough to be portable, the new model of the microscope makes one of science's latest and most powerful tools available to war work on a wide scale. It is capable of magnifying infinitesimally small particles of matter up to 100,000 times. In this respect it equals in performance the standard size instrument, introduced some two years ago.

Dr. Zworykin made it clear, however, that the standard electron microscope, a highly flexible instrument equipped with special adaptors for various types of investigations, is by no means superseded by the new small model. It has been found, he explained, that in numerous electron microscope researches the versatility of the larger instrument is unnecessary

"In the study of colloids, viruses, and macromolecules, in particular," continued Dr. Zworykin, "a fixed magnification and a relatively low operating voltage, giving large contrasts, has proved most satisfactory. Hence a new electron microscope has been developed, distinguished by extraordinary compactness and simplicity of operation Mounted on an ordinary desk, the microscope column, from electron source to fluorescent screen or plate, measures only 16 inches." (Height of the standard electron microscope is 7 feet.)

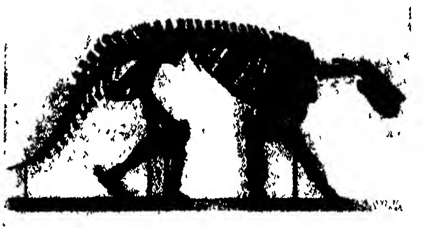
"The magnification of the (new) microscope, which operates with two magnetic lenses of fixed strength, is approximately 5000," he explained. "Since the grain of the photographic materials normally employed is fine enough to permit twenty-fold enlargement, micrographs with a total magnification of 100,000 may be obtained with the instrument. This is adequate to make use of the full resolving power of the microscope."

SYNTHETIC TIRES

Being Tested, but None Yet for Public

TIRES whose rubber content is 99.84 percent synthetic rubber are now being tested on the highways in various parts of the country, according to Dr. Howard E. Fritz, director of research of the B. F. Goodrich company. In discussing the present relative positions of natural and synthetic rubber from the standpoint of their usefulness in tires, Dr. Fritz emphasized that this testing of high-percentage synthetic rubber casings should not be considered as indicating any early public availability of such tires—that it does

10,000,000 years before Barylambda appeared on the scene. This revolution was the transition from the age of reptiles to the age of mammals, which was ushered in by the dramatic and world-wide extinction of the dinosaurs and other giant reptiles that had dominated land and sea. At the beginning of this epoch the mammals were small to medium in size. Once they had succeeded to dominance, however, diversification and specialization along many lines went on rapidly, resulting finally in the animal world we know today. One line of specialization was the acquisition of large size This evolutionary trend especially characterized various orders of the great hoofed mammal stock, exemplified among living animals such as elephants, rhinos, and hippos.



Photographs courtesy Field Museum of Natural History
A reconstruction of Barylambda and, *right*, the skeleton as now exhibited

not affect the nation's tire supply situation at all

"Experimental development work done with samples of butadiene-type synthetic rubber — the type which makes up the great bulk of the government synthetics program—has already shown up much that is good and several things that are still unsatisfactory about this new rubber," he said

"Passenger tires and small-size truck tires give excellent service. When we come to large-size truck and bus tires, several difficult problems arise due to the fact that synthetic rubber while running generates more heat than natural rubber, and may fail from that cause in spite of its higher heat resistance However, we are now hard at work on this problem and are confident it can be solved as we gain more experience in the field"

BRAZILIAN R. R.

To be Electrified to Save Coal

In order to avoid excessive cost of importing coal to run its railroads, Brazil has embarked on a long-range railroad electrification program designed to make the republic self sufficient with respect to power, and at the same time independent of foreign sources of fuel.

The country has abundant water power, but is faced with the wartime problem of obtaining necessary turbines, generators, wiring, electric locomotives, and other necessary equipment.

First line to be electrified is a 90-mile section of the Sorocabana railroad, between Sao Paulo and San Antonio The project, said to be the largest now under way in the Western hemisphere, is expected to cost about $10,000,000, and to be completed within three years

Heavy rails are now being laid, and the 80 ton steam locomotives formerly in use are to be replaced by electric locomotives of 180 tons—said to be the heaviest electric locomotives ever built for narrow-gage track. Trains will be longer and will travel at greater speed

Seven thousand poles to support the electric lines will be made of reinforced concrete. Power for the line will be supplied by three secondary plants

Electrification equipment is being purchased from the United States.

The Sorocabana Railroad, owned by the state of Sao Paulo, is 1316 miles long—*Engineering News-Record.*

BARYLAMBDA

Restoration of Heavily Built, Extinct Mammal

A practically complete skeleton of Barylambda, an extinct mammal which, when it lived 50,000,000 years ago in west-central Colorado, attained a development entitling it to be rated as one of the most heavily-built animals of all time, has just been placed on exhibition in the hall of paleontology at Field Museum of Natural History, Chicago

"Barylambda was unlike and unrelated to any present-day animal," states Bryan Patterson, acting curator of paleontology, who led the expedition which excavated the remains of the rare creature. "It appeared during the course of the greatest revolution of life the earth has ever seen—a revolution that had been in progress about

These were preceded by a great variety of extinct groups of which Barylamdba and contemporaries were earliest.

"Barylambda stood some four feet high, had an overall length of about eight and a half feet, and its width across the hips was almost equal to three-quarters of its height. Its bones were extraordinarily massive, indicating the possession of immense muscular power. The head was small in comparison to the size of the body. It had a long, large tail, flattened somewhat from side to side. It was found under conditions which indicate that at the time of its life this part of Colorado was a broad flood-plain. Rivers and streams from the Rocky Mountains evidently meandered back and forth across the plain, the climate was warm, and the vegetation was heavy. Barylamdba was well-fitted for such an environment —its strong body was adapted to forcing a way through the tangled vegetation, and its teeth indicate it was vegetarian in diet. Its broad spreading five-toed feet supported its great weight well on soft, treacherous muddy ground, and its large compressed tail suggests it was a capable swimmer"

DIESEL PROPHECY

Will it Replace The "Iron Horse"?

An old familiar institution will someday be only a memory, in at least one man's opinion:

The steam switching locomotive, the

great puffing behemoth whose friendly sinew has inspired so many boys to become its master at the throttle, is obsolete. No more new ones will be constructed for American railroads

This prophecy was made recently by B. B. Williams, president of The Cooper-Bessemer Corporation, Diesel engine manufacturers, who said the lovable giant's place is rapidly being taken by an unromantic midget not much larger than the steam locomotive's tender.

The midget, run by Diesel power, is being turned out in large numbers to meet the increasing demands of American railroads and industry which have a tremendous volume of war materials to handle

"The old steam switching locomotive is gone," Mr. Williams said. "Of course, the ones now in use on the main lines will be rebuilt and repaired until they are run to the thin end. But no new ones will be constructed."

The chief reason for the old friend's demise is its failure to develop enough power from a dead stop, the Diesel manufacturer pointed out. After it gets up enough speed it is powerful enough, but in getting up speed much effectiveness is lost.

According to Cooper-Bessemer engineers, a Diesel switch engine, in a head-on contest, would back up a locomotive three times as powerful and with full steam up.

They explained that both the direct-drive Diesel and the Diesel-electric switching locomotives show better performance because of their enormously increased starting torque The steam switching engine requires some time in the acceleration of its driving wheels to develop a comparable pull

EXPLOSIVE FISH

Sardines Furnish Glycerin for Explosives

THE government's "scrap-fat drive" to obtain new sources of glycerin and soap acids asks housewives and restaurants to save their grease drippings for defense. From these scrap fats the government expects to make glycerin for explosives, replacing the imports of cocoanut oil from the Philippines and other Pacific Islands, which were cut off by the war.

In searching for increased sources of glycerin-producing fats, the government is also increasing domestic production of various plant oils, including soybean, peanut, flax, and cotton. But there's another not-so-widely publicized source which has been providing the United States with oil-producing glycerin for two decades—sardines and herring, which inhabit the Pacific Ocean from Alaska to Mexico—and this source has a distinct advantage, in that the product needs only to be harvested, it requires no preliminary planting and cultivation.

Although the average production of 2,000,000 gallons of herring oil obtained yearly from Alaska will be curtailed somewhat this year, due to the government's prohibiting fishing in certain areas, there will still be sardines caught off the Pacific Coast from British Columbia to California—and production of pilchard oil on the West Coast alone has averaged 13,000,000 gallons yearly.

Tests of the pilchard oil, which have been made in Laucks Laboratories, Inc, in Seattle, since 1921, have shown more than satisfactory glycerin content, and the lowly sardine and herring are finding themselves blasting away behind the front lines. Not as powder for guns—because nitroglycerin (glycerin, plus acids) is too violent to be used in this way, but as dynamite and other explosive preparations which are the

mainstays of the Engineer Corps and others. This is very important in clearing roads for troops and tanks and guns and trucks rushing to the front, in excavations for new munitions plants, mines, and new road construction. Also, huge amounts will be used to destroy bridges, and to clear away debris in bombing attacks.

Glycerin, in normal times, was more than 90 percent manufactured as a by-product of soapmaking. Now soap is definitely a by-product of glycerin.

Sardines and herring are a logical source of glycerin. They're easily caught, and studies of their migratory habits have proved that they reappear year after year in large schools in the same places. They don't swim too far off shore, spawn prolifically, and are so thick in schools that it's possible to catch 35 or 40 tons in one net.

In certain seasons there's a comparatively large quantity of oil in these fish—and the larger quantities of oil, the more glycerin. In fact, because of their excessive oiliness, sardines are not a favored article on the fresh fish market. In Laucks Laboratories, where sardine and herring oils are now being tested daily, it was found that the glycerin content of the oil of these fish was from 8 to 10 percent.

GUN MOUNTS

Require High Degree of Accurate Machining

RECORD-BREAKING production of gun mounts carrying four rapid-fire anti-aircraft guns—the weapons which hurled hundreds of shells a minute at Japanese planes in the battles of Pearl Harbor, Midway, and the Solomon Islands—was disclosed recently by the Westinghouse Electric Elevator Company. These multiple gun units are being produced by Westinghouse at a saving to the Navy of more than 10 million dollars in cost and 4,400,000 man-hours of work.

"Before we tackled the job in the summer of 1940," explains Frank C. Reed, president of the elevator company, "each gun mount required 8500 man-hours of labor and cost about $27,000—but assembly-line production methods enabled us to turn out each unit with about 2100 man-hours of work at a cost of about $12,000. Difference between estimated cost and actual cost were returned to the government. By May, 1942, we were turning out nearly 40 percent more mounts each month than our contract called for."

Weighing 14,000 pounds, each mount consists of an adjustable four-foot long horizontal gun support, installed in an H-shaped stand which is moored to a revolving steel base. Each gun support has four large grooves, nine by 13 inches, into which water-cooled gun barrels are inserted. The four guns, although not synchronized, are fired in nearly simultaneous bursts by a single trigger mechanism on the left side of the unit.

Guided by sights on both sides of the unit, Navy gunners train the guns on flying targets by quickly moving them up or down and left or right. When necessary the entire mount can be swung in a complete circle. The guns are aimed manually by a series of easy-turning cranks near the sights, and also by hydraulic power controls which are installed when the gun units reach a ship.

Maneuverability of the mounts depends upon precision manufacturing at extremely close tolerances. Principal surfaces must be levelled to a point that engineers call "dead flat," with an allowable discrepancy of two-tenths of a thousandth of an inch. Other parts

High accuracy is required in these gun mounts, shown below when complete and in action, which are now being produced in huge quantities

must be accurate within four-tenths of a thousandth to a thousandth of an inch.

Just before the gun mounts are ready for shipment, sights that are used in actual combat are installed temporarily and tested for accurate alignment with gun barrels. Maximum allowable tolerance in this test is one minute, or one sixtieth of one degree—which would result in a deviation by the gun projectiles of not more than ten and one-half inches per thousand yards.

SOLOMON ISLANDERS

Led Easy Life—Until War Intervened

FEW peoples on earth are less known to ethnologists than the short-statured hairy, Melanesian black men of the dense jungles and lofty mountains of the Solomon Islands, say ethnologists of the Smithsonian Institution Throughout the archipelago, now the scene of some of the most crucial fighting of the war, ways of life differ widely from island to island, Smithsonian ethnologists point out. So great has been the isolation that in some cases villages a few miles from each other speak different languages. But all belong to the same basic Melanesian stock as the inhabitants of New Guinea, most of the neighboring groups of islands, and probably Australia.

The Solomons gained a bad reputation as "the cannibal islands." There is little evidence, however, that the Melaneasian peoples ever were cannibals, other than ceremonially. The central islands of the archipelago were,

however, a center of the curious head-hunting custom which in most places has been suppressed under the Australian mandate. A head—and it need not be that of an enemy—was considered a token of valor and was a cherished possession. A young warrior needed a good string of skulls to have much prestige among the women of his village.

The Solomons were in the stone age stage of culture when first visited by the whites and, for the most part, have advanced little. They have been slow to accept white influences, and few peoples on earth have been less exposed to these. But the people can hardly be considered as a very low grade of aboriginals, such as the long-extinct natives of Tasmania, to whom they probably were distantly related. They had developed a rather advanced system of agriculture, effective boats and weapons, and an exceptionally complex economic system. To a high degree they had domesticated the pig.

By and large, life to the Solomon Islander is easy and, from his point of view, luxurious. Little work is required for his crops. Most of this is done by the women. The men, as among so many primitive peoples, are hunters and warriors. But neither sex works very hard at its traditional vocations, although the islanders are good workers for short periods on plantations

• • •

BIRDS—Among the strange birds on Guadalcanal are the brush fowl, which buries its eggs in a mass of fermenting dead leaves which acts as a natural incubator; and the dwarf climbing parrot, a little bird no bigger than a sparrow, that climbs trees like a woodpecker and makes its home in the nest of termites which appear to be its principal food.

• • •

EARTH SHOCK

Is Responsible for Much Bomb Damage

Earth shock, one of the most dangerous and least understood effects of bomb explosions, endangers large and small buildings of nearly every type of construction and foundation in an area under attack, according to Professor William H. Hayes, of the Columbia School of Architecture.

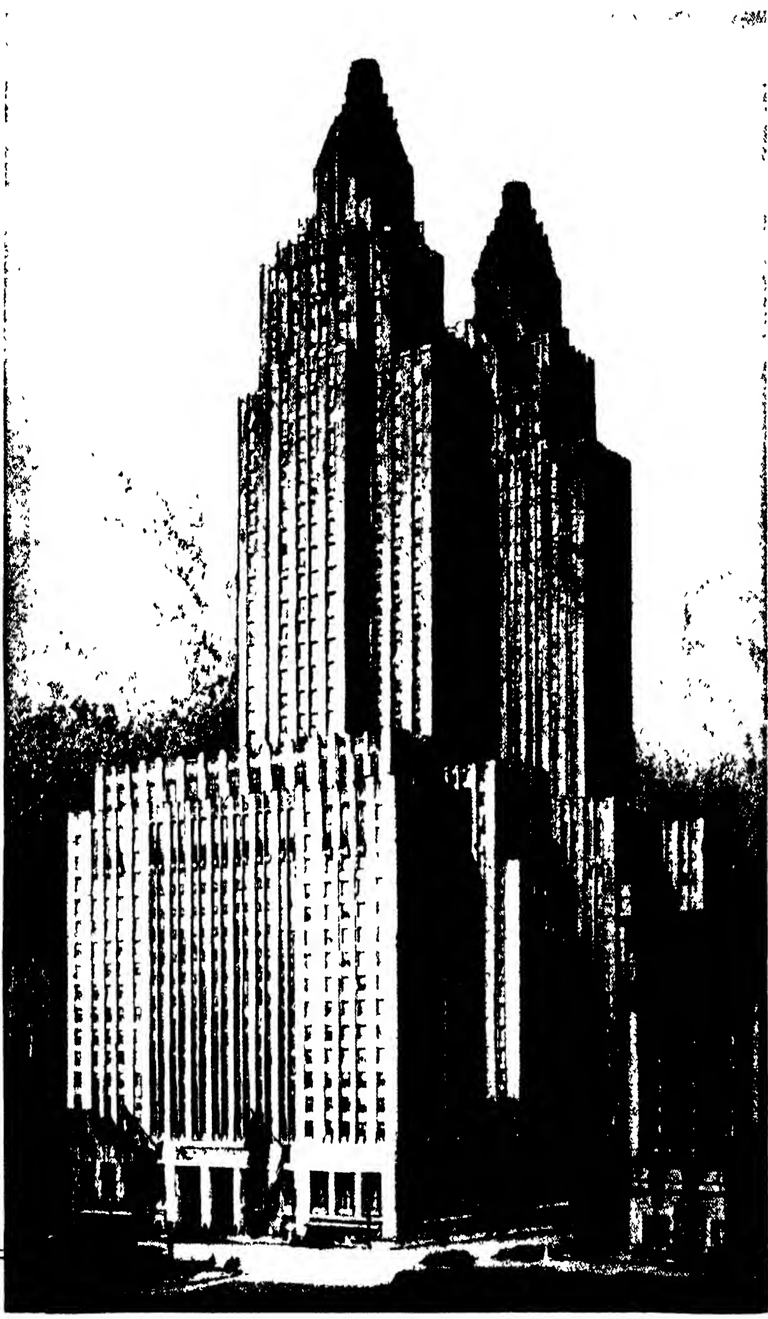
With the exception of all-steel or concrete frame buildings, all structures are affected to some degree by the vibrational effect, or earth shock, produced by a bomb explosion below the surface of the earth, an effect which is similar to that of a local earthquake, except that earthquake movements may be said to be slower, says Professor Hayes.

"Few phenomena are more troublesome at times or more baffling than vibration," he declares. "It is a force that has long been recognized, though not generally too well understood. The severity of a vibrational action is measured by: its acceleration, or an increase or decrease in the speed with which it travels; its amplitude, or its size; and its frequency, or the number of vibrations occurring per second.

"These factors are large or small depending mainly on the magnitude of the explosive charge and the nature of the ground—clay, loam, or rock, for example—in which the explosion occurs. Buildings on unstable ground are generally more severely damaged than those on firmer ground, and moist ground usually responds to earth shock more violently than does dry ground

"The earth reacts when disturbed by an explosion much as water behaves when a stone is dropped into a still pool, concentric waves traveling outward, away from the point of origin, with a decreasing velocity and with decreasing amplitude or height. The frequency of the waves, that is, the number of waves that pass a given point in a certain space of time, depends in part on the impact with which the stone struck the water.

"Another aspect of earth shock which renders it dangerous is its characteristic of traveling rapidly in a vertical direction, and more slowly in a horizontal direction. Consequently, any subsurface structure, such as a foundation or a shelter, may be first lifted by the vertical component and then moved horizontally by the horizontal component The effect on a non-flexible structure is obvious Wall-bearing

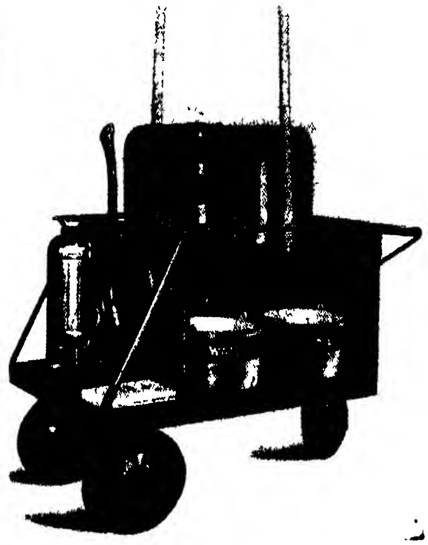


buildings, or those whose walls support all other parts, and unreinforced masonry buildings, fare badly from the effects of earth shock," Professor Hayes concludes.

AIR-RAID UNIT

Small Truck Carries All Needed Supplies

INTENDED to transport fire-fighting equipment and first-aid materials to the scene of a fire, a new welded steel hand truck is of particular interest for air-raid service. Allocated spaces on the truck provide for water and sand, stirrup pumps, hose, shovels, and so on. The center steel panel can be used as a shelter while fighting a fire. Mounting of the truck, which is 43 inches long, 29 inches wide, and 40 inches high, is on two fixed and one swivel wheels.



Carry-all for air raids

NIGHT ACCIDENTS

On the Increase As Result of Several Factors

WITH night traffic accidents showing a decided increase in proportion to those occurring during the daylight hours, street-lighting manufacturers have urged municipal and state lighting engineers to maintain their present illumination on the nation's thoroughfares, and to increase it in localities where war industries have created serious night traffic problems.

Reports from motor vehicle commissioners and state police officials reveal that the decline in daylight traffic deaths was not being accompanied by a similar decrease in night fatalities. In the State of New York, one month's night fatalities rose 19 percent, while

daytime deaths decreased 28 percent. Night-time fatalities are now two and three tenths the number of those occurring during daylight on Chicago's streets.

"The nation has been rejoicing about an overall decrease in traffic accidents without taking much time to analyze the reasons for it," says A F Dickerson, chairman of the Street and Highway Lighting Safety Bureau "What at first seems a gratifying result of our safety efforts resolves itself after closer inspection into a reduction in daytime accidents that is merely proportionate to the lowered volume of traffic. This is not usually true of night fatal accidents, however In most localities their decline is not keeping pace with the daylight decrease.

"The necessary curtailment of street lighting in the dim-out areas is partly responsible for this Crowded road conditions around our war production centers have also posed a new and increasingly difficult problem In Michigan, for example, 50 percent of the drivers involved in traffic accidents are factory workers Over one hundred service men are hurt or killed on California's roads each month Three out of five persons killed by automobiles in Texas for the first half of this year were members of our armed forces

"Every safety device must be employed to its capacity in order to conserve life and limb for victory," says Mr. Dickerson "High among them is the humble street light If permitted to continue its vital function of furnishing visibility after darkness has set in, street lighting will have contributed a full measure to the winning of the war. It is as unthinkable to reduce street lighting in this emergency, except where dim-out regulations require it, as it is to imagine that safe, speedy transportation is not a cornerstone of victory"

ARMY SHOES

Available in 238 Sizes, Plus "Made to Order"

IF YOU'RE a man with peculiar feet, the Army's the place for you these days, according to *The Army Officer*. The Army's feet that are hard to fit are getting special measurement shoes that in civilian life could cost as much as $25 a pair. A survey of Army posts in the United States reveals that no army in the world has taken so many precautions to assure its soldiers of a correct shoe fit. Any soldier who cannot be fitted properly with one of the 238 different sizes provided in the regular service shoe is given special attention by an experienced shoe man. Accurate

measurements are taken at all parts of the foot, and a plaster cast is made, if necessary. To insure that the man may continue to get his special measurement shoes, his individual lasts are tagged with his name and identification number and filed for future use

RAFT INFLATOR

Gas in a Bottle Does the Job

THANKS to a ten-inch steel cylinder containing three quarters of a pound of liquid carbon dioxide, Army and Navy pilots forced to bail out over water now have a seaworthy boat with

Inflating the seat-pack raft

them when they reach the surface of the ocean. The new device, developed by engineers of Walter Kidde & Company, is attached to a rubberized fabric boat, which folds up, together with eleven items of equipment, into a bundle 17 by 5 inches and weighing 12 pounds It is worn by the flier as a seat-pack. In case of emergency the flier turns a valve on the cylinder, releasing the gas which expands 450 times and transforms the seat-pack into a five-foot, six-inch rubber boat

DUMB?

All Animals Said to Have Means of Communication

THERE are no "dumb" animals. This is the belief of Ernest P. Walker, Assistant Director of the National Zoological Park, after years of observation of creatures of hundreds of species. All, he contend, have some means of communication between themselves.

For example, he says, "a tiny pocket

mouse that lived on my desk for several years appeared to be entirely silent. But when I held him against my ear I found he was carrying on a rapid chattering and scolding. A little female of the same species, a temperamental spinster, had but to look at him, change her expression ever so little, and he would almost be cowed. I am satisfied she talked to him most effectively."

Kangaroo rats, Mr. Walker, says, generally are believed to be "dumb," but when two are brought together and do not like each other they utter buzzing growls. Also one will give the same sort of call when it is in the immediate presence of a grasshopper mouse, its mortal enemy in the wild.

"I have heard my little kangaroo rat," he says, "utter chirps that could be heard a distance of eight or ten feet. If one of these animals is held close to one's ear a series of buzzing sounds can be heard—dots and dashes in varying frequency and tempo—that must mean something to the creature who makes them In their deep underground dens a distinct tapping of feet or tails can be heard from outside. These sounds evidently serve as a means of communication between different nest chambers within the elaborate dwelling.

"My pet grasshopper mouse calls, apparently to attract attention The loudest of his calls can be heard by the ordinary human ear at a distance of 40 to 50 feet. I have seen him go through the motions of giving the call when the sound was so faint or high-pitched that I would not hear it when I was not more than two to four feet away from him"

The classic "dumb" animal, Mr Walker points out, is the giraffe but he contends that there are authentic records that these animals, under the stimulus of extreme excitement, utter bleating calls

MANHOLE COVERS

Now Made of Wood to Save Metal

ENGINEERS have solved one metal shortage by the development of wooden manhole covers, said to be equal in strength and durability to the customary metal lids. The Los Angeles county surveyor's office first manufactured the timber manhole covers when a local shortage of cast-iron covers threatened to delay an essential sewerage project at a new war housing project. Recently the WPB prohibited use of metal for manhole covers

One type of the new cover uses no metal—avoiding even nails through the use of glued-in wood dowels to bond the wood laminations. In an alternative method the planking is bolted together.

The cover, weighing approximately 130 pounds, is constructed of two by eight inch planking. It has a diameter of two feet, nine inches Built in either

Wood for metal

circular or hexagonal design, the covers are pressure-treated with a preservative salt solution to provide resistance against termites and rot

A metal saving of 250 pounds in the lid and 250 pounds in the concrete frame is possible by construction of the wooden covers which may be cut in local wood-working shops without extensive fabricating equipment Altogether there are 63.3 board feet of lumber in the cover and 0 140 cubic yards of concrete in the supporting frame

RUBBER SEEDS

From Santo Domingo For Experimental Work

THOUSANDS of seeds from selected Hevea rubber trees growing in the experimental nursery of the B F Goodrich Company on the island of Santo Domingo were recently presented to the Bureau of Plant Industry, United States Department of Agriculture, which has under its control a program for promoting the cultivation of rubber-bearing plants in the Western Hemisphere. Plans to collect the seeds have already been started by the bureau

The experimental nursery in Santo Domingo has been in operation since 1931. Test tappings have shown the presence of trees yielding as much rubber as some of the high-yielding hybrid trees of Malaya and the Dutch

East Indies, now controlled by the Japanese.

The trees are also free of the South American leaf blight, a fungus disease which has inflicted such damage on rubber plantings there that plantation development in the past has met serious obstacles.

The trees are the offspring of seeds collected in the uplands of Brazil where disease-resistant varieties are found. They are better adapted for growth in cooler climates than those found in equatorial regions, since the seeds were gathered from trees of Hevea brasiliensis (the world's best rubber producer), 6 to 10 feet in circumference and 70 to 80 feet high, at an elevation of 1100 feet and latitude of 14 degrees, South This is the outer fringe of the native habitat of this species of rubber tree in the Amazon valley.

As a result of surveys carried out over a period of years by the company, Santo Domingo was chosen as one of the most favorable sites in this hemisphere for the cultivation of rubber, and the nursery was established there.

In addition to the seeds, the company is supplying the Government with budwood from the high-yielding trees Both seeds and budwood will be used by the United States Department of Agriculture in its co-operative program with the Dominican Government and other Latin-American countries for the development of high-yielding, disease-resistant trees suitable for planting in the Western Hemisphere

FAN

Has Plastic Blades for Corrosion Resistance

PLASTIC-IMPREGNATED reinforced fabric is used to replace aluminum in the blades of a new type of fan for cooling-tower use The hub of the fan, of welded steel construction, is so designed that the blades can be clamped into it at the desired pitch position.

TANK DESTROYERS

Race on "Shoes" of Steel and Rubber

HIGHLY mobile, cannon-carrying "tank destroyers," capable of outsprinting their ponderous quarry over battle terrain, are described as a timely example of war-time "wedding" of steel and rubber.

The use of an endless-band type of track in which steel cables and cross-pieces are imbedded in rubber to form a "one-piece" belt, says J. D. Beebe, executive of the B. F. Goodrich Company, has "made possible a wide variety of army vehicles—tanks, tank destroyers, and 'half-trac' personnel and equipment carriers—which possess new low-rolling resistance, freedom from noise and vibration, higher speeds, higher traction, and greater all-around efficiency."

These "racing shoes" for the tank chasers, Beebe explains, are an outgrowth of work originally undertaken by his company in developing this type of band track for farm and special industrial uses They are so light and flexible, relatively, he said, that carriers can travel almost as fast on them as on wheels—over terrain that wheels alone couldn't negotiate — and they actually use some 200 pounds less rubber per vehicle than tires would require

LIGNIN IN PHONES

New Insulating Material Made from Paper Waste

LIGNIN now stands for a new kind of plastic which Western Electric engineers have adapted to telephone manufacture as a part of the Bell System's program of alternative materials that has already released hundreds of tons of war-vital materials for munitions manufacture.

You're going to hear a lot about this use for lignin, since with its development the engineers have turned a waste material into a valuable electrical insulation for communication equipment

For years the sulfite water waste pollution of the nation's waterways had been a major problem with pulp manu facturers, a major source of woe to fishermen Two-and-a-half years ago chemists discovered that a very tasty vanilla extract could be manufactured from the waste. The introduction of lignin as a plastic for piece parts in telephone apparatus, however, took more than a year of co-operative development work by W. E. engineers and

Making slabs from sheets of lignin

Fitting lignin insulation parts

the chemists from the paper supplier.

The engineers knew that if they succeeded in developing a new plastic fiber that would take the place of phenol fiber, widely used as an insulating material, they would divert to military use such war essential components of phenol fiber as cresylic acid, formaldehyde, resin, and paper. Today, lignin takes the place of phenol fiber in about two thirds of its former applications.

When lignin paper sheets come to Western Electric Works, they are conditioned to a definite moisture content, heated and subjected to high pressures, yielding a tough fiber board with—pound for pound—the strength of steel. Lignin fiber possesses good electrical characteristics, is less corrosive than phenol fiber, is readily punchable, and has many of the other properties of phenol fiber board.

Already placed on the lengthening roster of new W. E. insulating materials, lignin—as a result of continuing researches—will take its place in more and more manufacturing processes, a triumph of science which refuses to admit that there is such a thing as "waste."

TAPERED NYLON

Now Available to Replace Natural Bristles

To SYNTHESIZE a paint brush material with the taper, resiliency, and toughness of natural bristle has been a goal of chemists for a quarter of a century. It became a national necessity to achieve that goal quickly after Pearl Harbor, for virtually all bristle had been imported from China and Russia, and these sources of supply suddenly were shut off.

Nylon paint brush bristles, announced recently for the first time, not only have the required taper but also resiliency, toughness, length, and inertness to paint ingredients. Moreover, they wear at least three times longer than natural bristles. The achievement of this tapered synthetic culminates five years of intensive research in DuPont laboratories.

Today, the Government is preempting for military uses the entire output of a busy pilot-scale plant. Early next year two full-scale units are expected to be in production, but their entire output will be required by the military Nylon paint brushes for civilian use must wait.

In 25 years of experimentation virtually every type of resin material had been tried Then came nylon, the first satisfactory synthetic bristle material It was introduced in uniform diameters in 1938 Wearing several times as long as natural bristle, it soon was used in most of the quality toilet brushes as well as brushes for 22 different kinds of industries.

A year prior to this public introduction of a level bristle, Du Pont had started its chemists and engineers to work on tapered nylon. It was a comparatively easy job to spin a level filament of tough, resilient nylon. To spin a tapered filament was something else

All kinds of ingenious spinning devices were designed, tried, found wanting, discarded There was no "magic" at work here; rather it was the "sweat" of chemical engineering Finally a taper was achieved by pulling a continuous nylon filament from a special spinneret at a controlled variable speed That is, the size of the filament varies with the speed of pulling—thick diameters resulting at slow speeds, and thin diameters at fast.

This solved only one of many problems Nylon filaments, after being spun, have to be drawn to several times their original length; that gives them their strength and resiliency To draw these tapered filaments to several times their original length without snapping them at the thinnest sections was not easy. More months of labor and more research funds were given to this work before a satisfactory technique was developed

Means of conditioning the filaments so they would not curl, and of automatically cutting them to ordered size, had to be figured out before a plant could start operating. "Bugs" and "kinks" showed up, but were overcome At last the day came when tapered nylon streamed from the spinneret in quantity, ready for allocation to war jobs. In reality, the chemist and engineer, as they have so often done in the past, had produced a material superior to Nature's own in many of its properties.

Industrial Growth

New Products and Processes That Reflect Applications of Research to Industrial Production

RAPID PLATING

Possible With New High-Amperage Brush Unit

WHEREVER an electrical outlet is available, it is possible to set up a new portable brush-type electroplating unit and to accomplish overall or touch-up plating with a wide variety of metals. The power unit itself weighs only 30 pounds, has duplicate outlets so that two operators can use it at once, and delivers controllable power of from

Brush plus paste plus current

1 to 25 amperes, D.C., at from 2 to 10 volts. Although designed for A.C. operation, the unit may be used on D.C. with a converter.

The portable nature of this unit makes it feasible to apply metal plating to parts of equipment without dismantling, the unit is connected to the part to be plated and the operation is completed right on the job. Electrical companies are using this plating method for protecting copper bus-bars and switch parts against corrosion by the use of a silver coating, thereby at the same time obtaining higher electrical conductivity; it is being used to apply zinc over welded seams where the protective coating has been burned off; anti-corrosion deposits are being made with it on vats, tanks, and so on; it will deposit hard nickel-cobalt facings on steel press dies; in other fields it is finding similar and even more wide-spread uses.

The power unit is connected, when in use, to the part to be plated by one cable; another cable terminates in a metal anode, the composition of which is determined by the metal to be deposited. This anode, in the plating unit made by Consolidated Equipment, is enclosed in a nylon filament brush of a size corresponding to the anode and to the work to be done. The work pieces, after cleaning and preparing, are coated with a plating solution in thin paste form, the paste being applied by the brush and kept in a state of constant agitation. The result, it is claimed, is a uniform deposit of close-grain plated metal which is completely and securely bonded to the base. Speed of application is high, for example, a 00025 of an inch plate of pure silver can be applied over an area of one square foot in approximately 30 minutes Tin, cadmium, zinc, copper, and so on, can be deposited at comparable speeds

TIMBER TRUSSES

Used in Construction of Pre-Fabricated Plant

A STRIKING example of the use of pre-fabricated structural timber is afforded at a large aircraft plant nearing completion in eastern Canada The production floor of this factory has eight bays 99 feet wide with columns 30 feet apart in the other direction. A sawtooth roof, framed into the main trusses, provides natural light throughout the plant.

Main trusses, of 99-foot span, have top and bottom chords of two 6 by 14-inch timbers, with verticals of single 6 by 10 to 6 by 14-inch pieces between the pairs of chord members The diagonals are pairs of square rods welded into slotted gusset plates that have flanged shear plates welded to them for connection to the timber truss members. Split-ring connectors and bolts are used for all wood-to-wood connections.

Columns are formed with two pieces of 6 by 16's and one 7 by 16, the latter being in the middle. The members are made into a laminated unit by inserting ring connectors and drawing the pieces tightly together with bolts. Throughout most of the factory the columns have an unsupported height of 22 feet

to the underside of the trusses, but this is increased to a clearance of 35 feet under the trusses at one end. The columns extend to the top chords of the trusses, which are spliced on a single gusset plate at that point.

Over 1,000,000 board feet of Douglas Fir timber were required for the structural frame, and more than 100,000 ring connectors were used The complete frame was accurately prefabricated at a West Coast plant and shipped to the site, knocked down and marked, ready for assembly and erection.—*Engineering News-Record*

GREASE SOLVENT

Used With Water

As Vehicle

ACCUMULATED grease on concrete floors is readily and completely removed by the use of a new solvent known as Turco Aktiv. This solvent is marketed in granular form and is to be dissolved in water before use A suitable solution is mopped on the greasy floor and allowed to stand for three to 15 minutes The solution, together with the dissolved grease, is then mopped or brushed up, while working, it does not fume and is nontoxic.

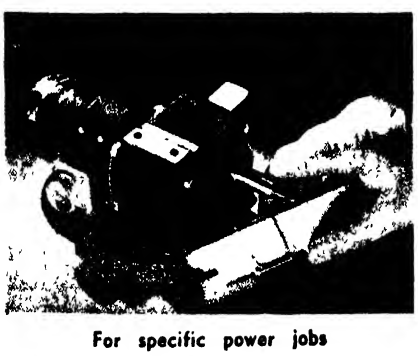
POWER PACKAGE

Provides Many Items for

Specialized Purposes

A NEW driving mechanism—the power package—has been especially devised for use in aircraft subassemblies The design of a particular power package depends upon the application for which it is built and designs are now available for such applications as bomb-door operation, landing-gear and wing flap operation, and operation of control and protective devices.

The new General Electric power package combines in one compact unit as many items as a motor, brake, clutch, and limit switch as well as indicators, gears, and whatever else is required to do a specific job. They are



For specific power jobs

designed for 24-hour service, and can be obtained in ratings from about 1/100 to 3 horsepower.

Each element in the power package is reduced to its simplest terms to save weight and space. For instance, where either a brake or a clutch could be used, the brake is chosen because it has one moving part while the clutch has two.

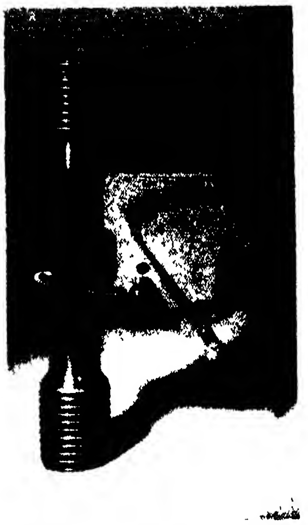
A new planetary gear system permits the use of a magnetic brake in the power package for some applications. The brake is of the quick-acting friction type and stops the motor quickly to prevent overtravel and consequent jamming

STRAIN GAGE

Now Available For

Structural Testing

THE Porter-Lipp strain gage, an American built instrument, is now offered to meet the demands of the recent rapid development of volume and technique of structural testing in this



Accurate to 0.00002 of an inch

country. A mechanical type of gage, the Porter-Lipp is accurate, light, compact, rugged, and convenient, yet inexpensive The strain multiplication factor of this gage is approximately 300 and it has a range of 0.008 of an inch or better.

Weighing only 0 4 of an ounce, the gage has overall dimensions of 1¾ by 2 by ⅝ of an inch It is graduated so that each division corresponds to a strain of approximately 0 0001 of an inch and has a readable accuracy of 0.00002 of an inch for a gage length of one inch.

The gage is said to meet the requirements that have grown out of the specialized needs of the present emergency and to have proved itself superior to similar devices imported from Europe before the war.

Freight Planes

Future Cargo-Carriers of the Air May Supplement, But are Unlikely to Supplant Surface Transportation

ALEXANDER KLEMIN
Aviation Editor, Scientific American
Research Professor, Daniel Guggenheim
School of Aeronautics, New York University

NO ONE is more confident of the future of air transportation than the writer of this column, but he is also aware of the danger of undue expectations against which W. A. Patterson, youthful, energetic and capable president of United Air Lines, voiced a timely warning. In his address before the National Industrial Conference in New York City, Mr Patterson said: "The airplane is destined to occupy a much more important place in the international scheme of transport and communication of our new world. However, I feel this picture is being harmfully distorted by over-enthusiastic predictions of the extent of postwar use of the airplane for freight transportation "

The speaker predicted that all first-class mail of the future would probably be carried by air, that the airlines and the railroads would compete for certain types of passenger traffic and for certain types of express package traffic But quite definitely the airplane would *not* make serious inroads on the freight revenues of railroads and steamships The reasons given were similar to the reasons offered by those who oppose too great a concentration of our war effort on cargo airplanes, and comparable to considerations which led the Navy Department to cancel an order for great numbers of the Vought-Sikorsky cargo-carrying flying boats

For freight carrying, the airplane's service is too limited and too expensive and the following remarks are cogent and conclusive: "Based on peace-time conditions and using as examples the present types of operating equipment, a normal freight train could deliver 1560 tons between Chicago and San Francisco at a total cost of $50,000. A fleet of 57 airplanes of the DC-3 type, now in use on commercial airlines, would be required to carry the same amount of cargo between the two cities in one month, at a total operating cost of $1,750,000."

If ocean-going cargoes are considered, the situation again is definitely not in favor of the airplane as far as heavy, large quantities of freight are concerned. A 13,000-ton freight steamer of the type now being constructed for the Maritime Commission could carry 6400 tons between San Francisco and Australia in the round trip time of two months at a total operating cost of $120,000. A total of 144 airplanes of the four-motored type would be required to transport the same amount of freight in the same period of time at an operating cost of about 250 times as much. Even if advanced engineering research was utilized in reducing transportation costs by air from, say 40 cents a ton mile, to 10 cents a ton mile, the cost would still be many times greater than the cost of surface transportation which measures its ton-mile costs in mils, not in cents

United's Patterson

Four conditions have to be met before freight, properly speaking, as distinct from express, can be carried by air. They are: An emergency has to be met; an opportunity exists for saving in warehousing and inventory costs; commodities are so valuable that financial and insurance costs are important; surface transport is inadequate or non-existent. Mr. Patterson is perfectly right in his contentions Air cargo will supplement but not supplant surface transportation, and fears that railroads and steamships will disappear under the competition of the airplane are groundless.

ZERO TRUTH

Is Not so Alarming as Early Reports Indicated

We have heard so much about the deadly Japanese Zero fighter, and what it was doing to our boys in the Pacific, that we have taken special pains to ascertain the truth from a reliable source. The Zero is a single-seater fighter, equipped with a 1000-horsepower air-cooled engine. It is of modern aerodynamic design, and in the hands of one of our test pilots it has fully lived up to its reputation of high maneuverability, fairly high speed, wonderful climb and ceiling. It does not come anywhere up to the speed of our fighters, though it has comparable climb.

The Zero is much lighter for the same horsepower than American machines, and, of course, very much lighter than American single-seater fighters which have greater engine power. It is excellent as an interceptor of the bomber plane. But these fine qualities have been attained by the ruthless sacrifice of others, namely, fire power, armor protection for the pilot, self-sealing tanks, and ruggedness. If the Japanese plane can instantly get on the tail of one of our machines because of its greater maneuverability, then our man is liable to be in real hazard. But if the fight goes on beyond the first burst of fire, then the American machine with its greater fire-power, its self-sealing tanks, its robust construction, and ability to withstand fire can almost invariably knock the enemy out of the sky. The situation is not so alarming after all!—*A.K.*

WARTIME PROPELLERS

Are Blacked Out by Conveyor Painting Process

For the duration of the war, the bright, flashing, beautiful surface of an airplane propeller has gone, because experiments have shown that a dull, black-painted blade reduces visibility to the enemy and also produces less reflected glare for the pilot. For safety when on the ground these days, the tips of the blades are painted yellow. For this additional task of blacking out the propeller, Hamilton-Standard devised a rapid conveyor-type spraying process. The endless-chain conveyor takes the blades through several chambers in which the several operations in the paint job are carried out, and blackened blades can be turned out at the rate of one every minute, the entire operation requiring only 41 minutes. In the first chamber the blades

One a minute

are cleaned in hot, vaporized "tricethylene", which removes all dirt and grease. Next, the blades are put into a chamber where blowers dry and cool them. A priming coat of zinc chromide is sprayed on in the third compartment, and drying at 160 degrees, Fahrenheit, and cooling by blowers carry on the process. Then the tip is sprayed with yellow paint, and the blade passes on for the final coat of black paint.

So perfectly balanced must an airplane propeller be, that it is carefully re-balanced after the above operations, even though the applied paint weighs but a small fraction of the weight of the whole propeller.—*A.K.*

PARACHUTES

Pioneer Parachutist Writes a Manual

There are some interesting items to be found in the "Parachute Manual," written by J. Floyd Smith. A historical note: on July 24, 1808, a Pole, Jodaki Kuparento, safely escaped from a burning balloon with a parachute—the first recorded instance of a parachute being used for life saving purposes. The early chutes were of many and varied designs and had very little stability. Fatalities were frequent. But in 1880, an American, Captain Thomas Baldwin, invented the vent in the peak of the canopy. The escaping air causes a vortex which provides a stabilizing effect on the parachute during the descent and enables the jumper to select his landing location with more safety and wider latitude. Since those early days the technique of the parachute has developed enormously. Parachutes now open very quickly, avoid shock, though they may be heavily loaded, are ready for instant use, and give splendid service to our air troops.—*A. K.*

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with the names of available books, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for. Books listed in these columns may be ordered from our Book Department.

YOUR INCOME TAX

By J. K. Lasser

Brief, straightforward explanation in clear, non-technical language of what must be done about your federal income tax, when and how to do it. Simply, yet completely, arranged with excellent cross-references. For those preparing their own or first return; for those interested primarily in legal deductions; for men in the Armed Services; for salaried men, business men, partnerships, husbands and wives, farmers, estates, trusts, and minors. Contains list of possible deductions available to those in 312 different jobs and professions. By mailing postcard contained in the book, you may obtain free supplementary service to keep abreast of federal tax law changes prior to March 15, 1943; also, a free supplement covering income tax laws for your state. Author is a Certified Public Accountant. (151 pages, 8½ by 11 inches, indexed.)—$1.10 postpaid —*A.D.R., IV.*

POPULAR MATHEMATICS

By Denning Miller

Anodyne for those who have mathematical indigestion. More than any of the numerous mathematical crutch books recently published, this one gets down to the average lone sufferer's level and it really purrs. That is, the text is more largely chat than formula, and its atmosphere is friendly and helpful and distinctly sympathetic. It is to a typical textbook as a kindly outside tutor is to a sour, dour, case-hardened, classroom instructor. Ground treated is arithmetic, geometry, algebra, analytical geometry, trigonometry, conic sections, solid geometry, spherical trigonometry, calculus. The coverage is not complete; it would not stand alone. It is, rather, a collateral book—and good friend. (616 pages, 5½ by 8¼ inches, illustrated.)—$3.85 postpaid. —*A.G.I.*

SCIENCE REMAKES OUR WORLD

By James Stokley

Applied science has many aspects and so has James Stokley, whose competence to present and elucidate them to a science-minded public is based on many decades of background in interpretive science writing. Here he deals with explosives, tomorrow's fuels, plastics, chemical clothes, rubber, agricultural and medical chemistry, vitamins, new metals, metals from sea water, glass, aviation of the future, electronics, radio, light sources, the atom, new power sources—all in a way to instruct and entertain. (299 pages, 5¾ by 8¾ inches, 35 illustrations.)—$3.60 postpaid.—*A.G.I.*

A-C CALCULATION CHARTS

By R. Lorenzen

Highly specialized time-saver, in the form of 146 charts, for engineers and others who work on electrical communication and power problems. With the straight-edge, provided in a cover pocket, it is possible to solve all alternating current calculations in series circuits, parallel circuits, series-parallel and mesh circuits, at frequencies from 10 cycles to 1000 megacycles. (10 by 12½ inches, printed in two colors.)—$7.60 postpaid.—*A.P.P.*

NEAR HORIZONS

By Edwin Way Teale

Relatively few scientists are heavily gifted with literary charm, while some of the most charming writers who have ventured into scientific realms were not very scientific. This author's writings do have charm and they also are scientific. This delightful work is an account of intimate observations of insect lives and affairs in an "insect garden"—just a typical patch of farmland. Its intimacy with the insect world is easily doubled by the author's remarkable close-up insect photography—not of dead bugs on pins but of real live ones in the field. This piece of writing should endure like those of Fabre, which it resembles. Not for study but for enjoyment. (319 pages, 7 by 9¾ inches, 100 illustrations.)—$3.85 postpaid.—*A.G.I.*

AMERICA AT WAR

By S. Van Valkenberg, Ellsworth Huntington, W. W. Atwood, Jr., W. Elmer Ekblaw, Clarence F. Jones, Earl B. Shaw.

Studies of and information on such vital wartime matters as The Quality of the People; Our Land and its Coastline; Terrain and War Strategy; The Climatic Factor; Foods for Defense; Industrial Capacity and Supplies of Raw Materials; United States Atlantic Defense; United States Pacific Defense; America and Peace. The six authors, each covering a

global and geographic phase which is his particular forte, offer this solid and profound treatise on the factors to be considered if a lasting peace is to be achieved after the war. (296 pages, 5¾ by 9 inches; maps, charts, tables, index.)—$2 60 postpaid—*A.D.R., IV.*

PLASTICS, PROBLEMS AND PROCESSES

By Dale E. Mansperger, M. A., and Carson W. Pepper, M. A.

THE whole story of plastics, including a resume of manufacturing processes and a number of chapters devoted to plastics uses, is presented in this thoroughgoing book written by men actively engaged in the work of which they write Main emphasis is on practical design and work. Appendices give lists of plastics manufacturers, and of supplies and equipment. (350 pages, 6½ by 9½ inches, profusely illustrated with photographs and drawings, a comprehensive bibliography, complete index)—$3 10 postpaid—*A.P.P.*

SCIENCE IN PROGRESS

Edited by George A. Baitsell

EIGHT chapters, respectively by Shapley (Galaxies); Hubble (expanding universe); Bethe (energy production in stars); Zworykin (electron image formation); Bridgman (high pressures); Marks (power generation developments); Franck (photosynthesis); Kirkwood (structure of liquids); Long (sulfanilamide); Marks (synthetic rubber). Not a highly technical book, but not light, popular stuff. Sigma Xi lectures. (322 pages, 6 by 9¼ inches, 112 illustrations.)—$3.10 postpaid.—*A.G.I.*

FIREARMS AND THEIR USE

By W. T. Castles and V. F. Kimball

A CONCISE review of various models of shotguns, rifles, and pistols with descriptions, instructional chapters on the use, and the intended purposes of the arms mentioned. Helpful for those learning the art of shooting as well as to instructors (232 pages, 5¼ by 8¼ inches, index, many illustrations.)—$2.10 postpaid.—*A.D.R., IV.*

AIRCRAFT SHEET METAL CONSTRUCTION AND REPAIRS

By M. P. Harrold

METHODS and processes described in this book are those which pertain particularly to aircraft construction and repair, yet much of the information given can be applied directly in production work. Emphasis throughout the book is on detailed instruction for actual jobs. (158 pages, 5½ by 8 inches, 123 drawings.)—$1.60 postpaid.—*A.P.P.*

HOW TO GET AHEAD IN A DEFENSE PLANT

By Kenneth C. Hawthorne

HOW to read blueprints; what to know about iron and steel; how to do simple mathematics; what should be

The Editors Recommend

Best Sellers in Science

PLASTICS — *By J. H. Dubois.* Meaty information on the whole general subject of plastics, presented in narrative form for easy reading. Tabulations of properties of plastics, plus basic design information, for laymen and technicians alike. **$3.10**

CHEMISTRY — *By Gerald Wendt, Ph.D.* Chemistry made easier by a presentation that is intermediate between popular works and classroom texts. This book contains the main substance of a first-year college chemistry course, giving the reader better than a sketchy background in this important science. **$2.35**

HOW TO READ ELECTRICAL BLUEPRINTS — *By Gilbert M. Heine and Carl H. Dunlap.* A chapter on how blueprints are made, plus nine other sections, each of which is devoted to a specialized part of the electrical field, from bell and signal wiring through motor control diagrams to power station blueprints **$3.10**

GET TOUGH! — *By Capt. W. E. Fairbairn.* How-to-win-in-hand-to-hand-fighting directions, by a man who really knows rough-and-tumble methods that are *not* "clean" fighting but *are* designed to win. **$1.10**

PLANE TRIGONOMETRY MADE PLAIN — *By Albert B. Carson.* The emphasis in this book, by an author who has tried to make the subject as painless as possible, is on practical applications rather than on mental gymnastics. A good book for the home user who wants to brush-up on trig. **$2.85**

TECHNIQUE OF PLYWOOD — *By Charles B. Norris.* Technical information on all phases of plywood manufacture and use, compiled for engineers, designers, and users of plywood. Important to many phases of wartime housing and manufacturing problems **$2.50**

FUNDAMENTALS OF RADIO — *By Jordan, Osterbrock, Pumphery, and Smeby.* With this one volume alone, and with some diligence of application, it is possible to obtain a thorough grounding in radio principles. In thoroughness of treatment, with due respect for the needs of the reader, this book is outstanding. **$5.10**

THE TRISECTION PROBLEM — *By Robert C. Yates.* Embodies mathematician's answer to would-be trisector. Gives chief dependable data on this never-ending dispute. Compact, crisp, concise. **$1.10**

ELEMENTS OF ORDNANCE — A textbook prepared for cadets of the United States Military Academy. Covers manufacture, the chemistry of explosives, types of weapons, mathematics of ballistics, etc. **$6.60**

AIRCRAFT INSTRUMENTS — *By George Ellis Irvin.* All types of instruments for aircraft use described for students, pilots, inspectors. Fundamentals, instructions. **$5.10**

FIRE FROM THE AIR — *By J. Enrique Zanetti.* Pertinent facts regarding incendiary bombs. History, modern types, materials, and the strategy and tactics of their use in modern warfare. **$.60**

MACHINERY'S HANDBOOK—*Eleventh Edition.* "Bible of the mechanical industry," enlarged to 1815 pages of latest standards, data, and information required daily in the shop and drafting room. **$6.10**

PROCEDURES IN EXPERIMENTAL PHYSICS — *By John Strong, Ph.D.* A wealth of useful data of a practical kind for the constructor, experimenter, and skilled craftsman. **$6.80**

STEEL SQUARE POCKET BOOK — *By Dwight L. Stoddard.* Practical methods of using the carpenter's steel square for layout work of all kinds. Time-tried methods used by two generations of carpenters and found both rapid and accurate **$1.00**

MATHEMATICS — ITS MAGIC AND MASTERY — *By Aaron Bakst.* Investment in approach to algebra, geometry, trigonometry, with time-savers **$4.10**

WORKING WITH THE MICROSCOPE — *By Julian D. Corrington.* For the serious beginner. Explicit, practical. **$3.60**

TOOL MAKING — *By C. B. Cole.* Instructions for making and using all kinds, from personal tools to arbor presses, lathes, planers, etc., in different metals. **$3.60**

THE ELECTRON MICROSCOPE — *By Burton and Kohl.* A well-written account of this newest tool of science, with all technicalities explained for complete understanding by average persons. **$3.95**

GETTING ACQUAINTED WITH ELECTRICITY — *By Alfred Morgan.* Phrased in layman's language and aimed at the average man who finds himself somewhat bewildered by electrical gadgets in his home, his automobile, and his place of business, the text of this book deals only with basic principles. **$3.10**

MILITARY BASIC COURSE — *By Capt. Frank X. Cruikshank.* Complete story of Army operations in handy pocket volume. Fabrikoid binding. **$1.35**

A MARRIAGE MANUAL — *By Hannah M. Stone, M.D., and Abraham Stone, M.D.* A practical guide to sex and marriage, covering fitness for marriage, mechanism of reproduction, prevention of conception, and similar vital subjects Answers questions most often asked these authors by their consultants **$2.60**

THE ADVANCING FRONT OF MEDICINE, *By George W. Gray* — Summary of the high points of our present-day knowledge of the nature of disease Alimentation, high blood pressure, the sulfa drugs, influenza, allergy, insanity, sleep, pain, drink, smoking, anxiety, cancer, aging. A truthful picture of the status of medicine **$3.10**

AUTOMATIC ARMS — *By Melvin M. Johnson and Charles T. Haven.* Comprehensively covers machine guns, machine rifles, sub-machine guns, pocket pistols, shotguns, sporting, military rifles in automatic classification **$5.10**

BASIC FIELD MANUAL, INFANTRY DRILL REGULATIONS. Practical working manual for commissioned, non-commissioned officers. **$.50**

HANDBOOK OF CHEMISTRY AND PHYSICS — A classic reference book recently revised and brought up-to-date to keep pace with recent research. Includes material on all branches of chemistry, physics, and allied sciences. Used in laboratories and by engineers throughout the country. Flexible binding, 2503 pages. **$3.60**

ATOMIC ARTILLERY — *By John Kellock Robertson.* Electrons, protons, positrons, photons, neutrons, and cosmic rays, all described for the layman in plain language. Also transmutation of the elements and the manufacture of artificial radio activity **$2.35**

● The above prices are postpaid in the United States. Add, on foreign orders, 25¢ for postage on each book, except as noted. ●

For Sale by: **February, 1943**

SCIENTIFIC AMERICAN, 24 West 40th Street, New York City

I enclose $...... for which please forward at once the following books:

....

....

Name ....

Address ....

Write us for information on books on any subject. We can supply any book in print.

——OUR BOOK CORNER——

known about simple alloys; taking measurements, wood and wood finishing; care of tools; knowledge of plastics; use of special instruments; lubrication. All these, and more, are delineated for the benefit of war plant workers by an author who has had a broad technological education and experience (270 pages, 4¾ by 7¼ inches Over 150 illustrations; index)—$2 60 postpaid—*A D R, W.*

THE AMATEUR SCIENTIST

By Stephen Thomas

STUDY of the place in society of the amateur scientist, using Philadelphia (where amateur science groups reach greatest numbers and variety) as an example. It shows what can be accomplished in any live community in the organization and conduct of amateur science groups based on zoology, aeronautics, geology, astronomy, botany, photography, entomology, and a large number of others. This is not a book on any hobby *per se,* but is aimed at organizers, museums, and the like (291 pages, 5½ by 8 inches, 17 illustrations) $3 10 postpaid.—*A G I.*

GETTING ACQUAINTED WITH CHEMISTRY

By Alfred Morgan

CONTRIBUTIONS of chemistry to our daily lives are here explained in terms of articles and products which we constantly use From this simple, yet thorough-going story, the reader can readily acquire more than a speaking acquaintance with many of the phases of this fascinating science. Also given is advice on building the home laboratory, and a number of practical experiments. (272 pages, 6 by 8½ inches, a large number of drawings and a few photographs.) – $2 60 postpaid —*A P P.*

THE EIGHT MILLION

By Meyer Berger

SUBTITLED "The Journal of a New York Correspondent," this book is by one of the country's best reporters. Berger's raw materials are people—the queer, quaint, curious, pathetic, and heroic. He combines the scientific objectivity of a seasoned reporter with deep understanding, sympathy, and a distinct bent for the nostalgic. The result is a series of more than two score vignettes of life in the New York that the out-of-town night club and theater visitor seldom sees. It's an up-to-date "Bagdad on the Subway." (334 pages, 6 by 8¼ inches, illustrated.) —$2 60 postpaid —*A D R, W.*

A SHORT HISTORY OF SCIENCE

By Charles Singer

SCIENCE, from its earliest beginning to now. The author is a distinguished British authority on such history. The text is compact and possibly too much so—a bit jerky, like a notebook,—possibly from an attempt to cover too many details in a given length Authoritative as a reference book. (399 pages, 5½ by 8½ inches, 94 illustrations.)—$3.85, postpaid.—*A. G I.*

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

Rubber Guide Book is a 32-page bulletin which covers the principle methods of manufacturing rubber products and places special emphasis on hydraulic equipment parts made from Ameripol synthetic rubber. Rubber gloves, sponge products, extruded goods, hard rubber parts, rubber cement, and so on, are some of the specific subjects covered *Miller Rubber Industrial Products Division of the B F. Goodrich Company, Akron, Ohio—Gratis*

Directions for Inspecting, Recharging, and Maintaining Portable Fire Extinguishers is a six-page folder stressing the importance of keeping fire-extinquishing equipment in good operating condition at all times. *Pyrene Manufacturing Company, 560 Belmont Avenue, Newark, New Jersey.—Gratis.*

Magnetic Separation of Ores, by R. S. Dean and C. W. Davis, is a 417-page book, containing 165 figures, which discusses briefly operations and trends in magnetic separation, explains the process, describes and classifies machines used, and outlines their development. Request Bulletin 425. *Superintendent of Documents, Government Printing Office, Washington, D. C.—$1 00 cash or money-order.*

Fend is a 16-page brochure which discusses the whole subject of industrial skin troubles, and describes different types of creams and lotions which have been developed for barrier protection against industrial dermatitis. Request Bulletin FA-79. *Mine Safety Appliances Company, Braddock, Thomas, and Meade Streets, Pittsburgh, Pennsylvania—Gratis.*

Housing Terms are given in a newly compiled glossary, the definitions being those that are generally accepted and currently used. Request "Building Materials and Structures Report BMS91." *Superintendent of Documents, Government Printing Office, Washington, D. C.—15 cents, coin.*

Tell It To Sweeney is a 16-page illustrated pamphlet showing the advantages to be had from a properly designed interplant sound system for industrial communication. Request this bulletin on your business letterhead. *Stromberg-Carlson Telephone Manufacturing Company, 100 Carlson Road, Rochester, New York.—Gratis.*

Vinylite Plastics for Wire and Cable Insulation is a 12-page illustrated booklet which reviews the advantages of these resin compounds for insulation purposes, from standpoints of installation, service, and safety. Tables which are included indicate physical and electrical properties of the compounds, and typical applications. Request this booklet on your business letterhead. *Haloway Products Division, Union Carbide and Carbon Corporation, 30 East 42nd Street, New York, New York.—Gratis.*

Rapid Review of Elementary Algebra, by Jonas T May, is a quick, efficient review for class or individual use. All main points are covered. Answers are given to all problems. *Emerson Books, Inc., 251 West 19th Street, New York, New York.—18 cents.*

Lithco Principles and Data is a 8-page booklet illustrated with charts and drawings which describe recent advances in heat-treating and carburizing atmosphere processes. Advantages of these processes are stressed, and sufficient general information is given to show how they are applied. It is claimed that these processes are especially suited to high-speed production work. *Lithium Corp., 42 Raymond-Commerce Building, Newark, New Jersey—Gratis*

Midget Metal Base Relays is a single sheet giving technical data on a type of relay widely used in small radio transmitters, aircraft circuits, and other places where space is limited. Request Bulletin 104 *Ward Leonard Electric Company, Mount Vernon, New York—Gratis.*

The Specific Heats of Certain Gases Over Wide Ranges of Pressures and Temperatures is a 22-page bulletin covering the subject of the title as applied to air, carbon dioxide, carbon monoxide, ethylene, hydrogen, methane, nitrogen, and oxygen Given are the general equations needed as well as graphs. Request Bulletin 30 *Engineering Experiment Station, Cornell University, Ithaca, New York—Single copies gratis*

Laminated Solenoids is a single-sheet circular giving engineering data on two new units designed for maximum magnetic force for a given electrical input. The units are of the pull and the push-pull types. *Dean W. Davis & Company, Inc., 549 West Fulton Street, Chicago, Illinois.—Gratis.*

Quality Production Tools is a 56-page listing of saws, drills, shapers, grinders, and so on, stressing their efficient applications to present-day production requirements Request Industrial Catalog No 10 *The Delta Manufacturing Company, 600 East Vienna Avenue, Milwaukee, Wisconsin.—Gratis.*

Princo Catalog 42 is a 42-page illustrated display of a wide range of electric counters and actuating switches, mechanical counters, and timing and recording devices. Many specific applications are shown. *Production Instrument Company, 710 West Jackson Boulevard, Chicago, Illinois.—Gratis.*

Books and Films on Lathe Operation is a four-page folder describing helpful material which has been prepared for training lathe operators Request Circular No. 21-C. *South Bend Lathe Works, South Bend, Indiana.—Gratis.*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

COLORADO's altitude and clear air provide encouragement to amateur astronomers, and one of these is John Bunyan, president of the Berthoud National Bank, Berthoud, Colorado, whose observatory, first pictured in these pages in January 1934, then consisted only of the nearer structure in Figure 1. This contained a meridian telescope (note covered roof slot). The square structure behind it houses, beneath a gantry roof which runs off to the right, a 10" Cassegrainian.

Just beyond this run-off roof a third has now been added, to house a camera and mounting. The roof of this addition rolls off to the north, and the south gable, visible in Figure 1, near the telescope, is hinged and lets down on a post.

Thus, John Bunyan, a pilgrim originally from New York State, has progressed from one to two, and from two to three, observatory entities. The recently added camera assembly (Figure 2) was built, Bunyan states, largely with the help of Carl Conder, a good local mechanic.

Bunyan writes: "The supporting frame and the rectangular polar axis are built of 5" channel steel. The ends of the polar axis are of 2" steel shafting, the lower, which carries most of the weight, resting on a thrust ball bearing. The upper bearing is plain. The declination axis is made of 2" steel shafting with one end threaded and screwed into a steel plate which is bolted to a piece of 3/4" plywood, 16" square. The camera and guiding telescope are fastened to the plywood.

"The counterweight at the other end of the declination axis is a steel pulley partly filled with concrete. The right ascension and declination circles are turned out of 3/4" plywood and are bound with brass strips (kind used to cover joints in linoleum). Tightly fitted over the brass strips are circles formed of 45" lengths of steel tape. Thus each 1/8" on the declination circle is 1°, and each 1/8" on the R.A. circle represents 4 minutes of time.

"The camera lens is a 4 1/8" group portrait lens of about 25" focus. The camera box is built of wood and is equipped with plate holders for 5" x 7" film. The eyepiece used in the guiding telescope is homemade. It has a biconvex lens and the crosshairs are made from tungsten filaments taken from an old style 25-watt lamp. These are illuminated by a flashlight bulb. A full sized dry cell, contained in a can mounted beside the telescope, furnishes the current. A volume control from an old radio is used as a rheostat to dim the light.

"A 12" cast-iron worm gear (Figure 3) with 96 teeth moves the polar axis by means of a friction clutch. This gear is driven by a single-thread hardened steel worm fastened to a steel shaft which carries a 30-tooth worm gear. The latter is driven at sidereal rate by a double-thread steel worm which turns at 1 rpm. A Hansen synchronous motor, with shaft geared to 1 rpm mean solar time, furnishes the timing and acts as a brake against the pull of a weight and sashcord over a plywood pulley on the polar axis Interposed between the 1 rpm motor output and the 1 rpm sidereal rate of the last-mentioned worm are spur gears giving a ratio of 364 to 363, which is the closest I could approximate the sidereal rate with stock gears. However, the error is so slight that it is inconsequential for the periods the camera is at work.

"There is a clamp on the declination axis with worm for slow motion. A worm connected with flexible cable moves the whole assembly in R.A., for manual guiding whenever a selected guide star strays from the crosshair.

"The whole outfit is carried on a heavy concrete pier and no part of the building touches it. Moving around in the building does not set up any vibration at all in the instruments."

Figure 3: **Bunyan's drive**

SUNDIALLING is a kind of cousin to amateur astronomy, and of course the average amateur's general reading in astronomy enables him to pick up its principles relatively easily. Figure 4 shows a stone sundial made by Bunyan, who also is the author of the chaper on making a sidereal clock, in "A.T.M.A." The base of the gnomon ("substyle") is 15" in length and this gives the scale of the other details The lines and numerals were not incised, but sandblasted at a local marbleshop, and are 1/8" wide by 1/8" deep. In cutting inscriptions, marble cutters, until a generation ago, used a hand chisel and mallet Then came the pneumatic chisel, and now this has been supplanted by sand blasting. The flat stone is first covered with a coat of elastic material and the desired lines and letters are cut through this covering—like a stencil. When a continuous blast of air-propelled sand from a nozzle is directed against this prepared surface, the sand grains rebound from the coating but strike the stone wherever it has been cut away, and thus they rapidly eat away the stone This method explains the deep inscriptions on the more recent tombstones—cuts far too deep and narrow to have been made by percussion tools

Figure 1: **Bunyan's family of observatories**

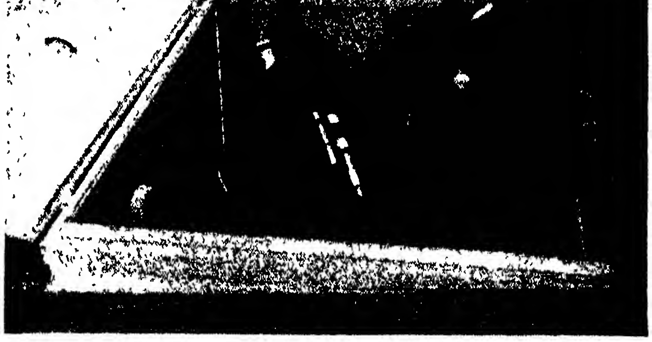


Figure 2: **The 4 1/8" camera and mounting**

Bunyan's dial is set up near his observatory. If really carefully designed and painstakingly made, a dial will give accurate time within about one minute, provided the daily correction for equation of time is made. Naturally, only a dial of this kind would suit the pride of the average amateur telescope maker.

This department often is asked for the "inside figures" on the total number of telescopes made since "Amateur Telescope Making" first appeared in 1926. We don't

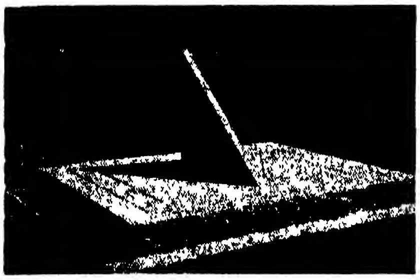


Figure 4: Bunyan's sun dial

know. To obtain really solid data on this would be difficult. All we can do, therefore, is "guestimate." Over 30,000 copies of "A.T.M." have been purchased since 1926, but what percentage of purchasers actually made telescopes? What percentage made two? Three? Five? Ten? (Yes, some have made that many). Our guestimate is 20,000 telescopes—what's yours? Some think this figure too conservative Perhaps. Perhaps not. Anyway, let's say 20,000.

It's fun to imagine all these 20,000 telescopes assembled in one place. Let's allot each one ten feet square and one observer That represents a Telescope Farm of about 50 acres, solid. Go aloft in a plane and look down at them all!

To make it more interesting, let's have them all pointed at one object; it might as well be the plane, and there'd be a poetic justice in having in the plane the man who, more than any other man, made it all possible—Russell Porter. Maybe he'll wave a hand over the side (this story is becoming melodramatic).

Of course, not all these telescopes are now in actual use. There must be a few thousands which could be put in other hands to good advantage. Readers also ask us, now and then, where they can purchase a second hand telescope. To test whether any good could be done by thawing out this frozen situation we shall be glad to publish, in one number, the names and addresses of those who have second hand telescopes they would be willing to dispose of.

Fun to make your own eyepieces. Whole battery of them (Figure 5, top and bottom) were made by H. J. Gebelein, 1314 Carey Ave., Davenport, Iowa, and are respectively 1¼", ¾", ½", ¼", 3/16" and ⅛" efl. Middle photograph shows some of the innards of the same eyepieces —those of the 1¼", ¾", ½" and ⅜". The eyepieces are the solid type (see "A.T.M.," page 178). The glass used was Chance Brothers C. C. Crown 1.51.

Gebelein also built an 8" Gregorian with

TELESCOPTICS

23" *f.l.* primary and ratio 6. "This telescope," he says," has given me many hours of real enjoyment."

TURRET for battery of telescope eyepieces is a decided convenience. In this department, November 1940, a 3-eyepiece turret was described. That turret was made on a lathe, but J. Irland, 22035 Donaldson, Dearborn, Michigan, says he made the 4-eyepiece turret shown in Figure 6 with-

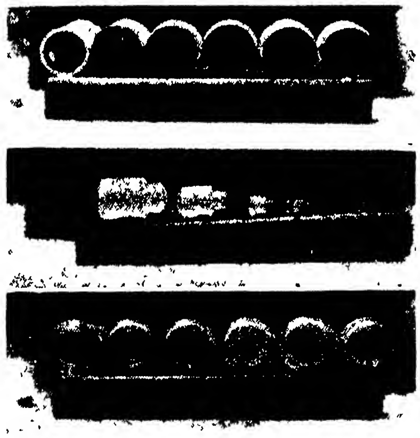


Figure 5: **Gabelein's battery**

out benefit of lathe. Two slices off a 4" brass rod, file, soldering iron, 1¼" tubing "I confess to some furtive assistance from a small drill press in hacking out holes to start filing on," Irland says, "but even that could be done by hand. Incidentally, one of the slices of 4" rod was a wedge, 3/16" thicker one edge than on the other, and hogging it down was as much work as roughing out a mirror But the thing works"

ABRASIVES are becoming scarcer, and methods for husbanding them, described by Lewis A. Parsons, 125 Brentwood Ave, San Francisco, California, should prove useful until the war is over

"In washing, or levigating rouge, the particles flocculate or bunch up, and thus the finer parts are dragged to the bottom with the coarse. I therefore disperse the particles, settle them, pour off the finer parts and then purposely flocculate these so that they will settle.

"Put, say, 4 oz. of rouge into a cleaned one-gallon bottle and add about 1 oz. of sodium silicate (ordinary water glass). Then fill the bottle with water, shake it thoroughly, and let it stand an hour. Next, siphon off the top half into another bottle, to which add perhaps 2 to 4 oz. (determine empirically) of lime water, a solution from slaked lime. This flocculates the rouge, which settles almost at once, permitting the clear water to be siphoned or decanted off. Then refill the first bottle, shake and repeat the operation. When the first bottle stops producing more, throw away the residuum. As the sludge settles in the second bottle, flush it into a mason jar and from time to time decant off the water. Use it as a cream or paste and do not let it dry. This produces beautiful rouge—not a scratch in a carload."

The following will similarly recover rouge, also Carbo and emery. The dispersing agent is Igepon AP Extra, sold by General Dyestuff Corporation, 435 Hudson St, New York, also 38 Natoma St., San Francisco, at a rather low rate in five pound lots. It is a detergent, and comes in powder or flakes.

"Grades of Carbo coarser than 240 settle so fast anyway that the finer stuff is best washed out first (elutriated by a gentle upward stream of water) and then dispersed and separated into its fractions. Carbo or emery that has been used a couple of times will yield as fine a product as desired. After the dispersed abrasive has been siphoned off, it is flocculated. The best all-round flocculating agent is ferric chloride. Caustic soda could be used for Carbo alone. *Caution:* Don't use it together with ferric chloride.

"The technique is simple. Shake up the abrasive in a bottle or jar with a little Igepon (experiment for exact proportion). Let it settle for a time based on the size you are after. Siphon off. Flocculate with ferric chloride. Continue the cycle till no more good stuff comes off. Dump the residue into a coarser size. Nothing is lost

"Many use too much abrasive with too little water, which prevents free settling. The grains hinder each other and there may be some big chunks in the part siphoned off. Use not over a quarter pound dry abrasive weight of abrasive, to a gallon of water For the very fine sizes and double levigation one would probably do better with five gallons for the final settling.

Figure 6: **Irland's eyepiece turret**

"There are evidences that glass will not flocculate and can be decanted after the good stuff has settled.

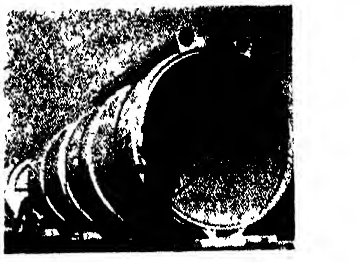
"Iron can be removed from the dried abrasive powder with a magnet.

"Some more work remains to be done on these methods.

"If some of the abrasive is placed on a slide under a microscope, the field will be seen to be made up of grains that fall in one size-group, yet the sizes are not all the same. Sticking out are usually a few much larger grains—enough to scratch. These are the grains whose grooves must be ground out with the next finer size, and which slow down the grinding process."

The methods described above by Parsons will prepare grades corresponding to the finer sizes of Carbo. In inexperienced hands they will not often duplicate the results obtained by the manufacturers since there is a vast amount of technique in grading abrasives and the manufacturers have spent years learning it. It will, however, approximate these results. It also will provide some of the finer sizes such as Carbo 1000 and emery 2600.

Press of the Wilson H. Lee Company Orange, Connecticut.



HEAT at 1650 degrees, Fahrenheit, will toughen gun barrels in the seven-ton Westinghouse electric furnaces, two shells of which are shown on our front cover. The furnace shells illustrated will later be lined with brick and equipped with chrome-nickel alloy heating elements. From these furnaces will come hardened and tempered gun barrels to blast the Axis.

•

•

SCIENTIFIC AMERICAN

Owned and published by Munn & Company, Inc., Orson D. Munn, President; I. Sheldon Tilney, Vice-President; John P. Davis, Secretary-Treasurer; all at 24 West 40th Street, New York, N. Y.

NINETY-NINTH YEAR **ORSON D. MUNN, Editor**

MARCH • 1943

SCIENTIFIC AMERICAN, March, 1943, Vol. 168, No. 3 Entered at the New York, New York, Post Office as second class matter June 28, 1879, under the act of March 3, 1879; additional entry at Orange, Connecticut. Published monthly by Munn & Co., Inc., 24 West 40th Street, New York City.

Files in all large libraries; articles are indexed in all leading indices.
Subscription rate $4 00 per year. Canada and foreign $5.00

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of March, 1893)

CANALS—"The promoters of the Nicaragua Canal scheme ask the United States government to guarantee their securities, and thus father the enterprise and hasten the work of construction by giving the securities financial standing . . . The Panama experience is a lesson from which much can be learned, and no patriot American would want it duplicated."

DRILLING RIGHTS—"The question of whether an oil operator has a right to drill through coal which has been leased previously, to reach oil or gas below, is one which has been the basis of a number of suits, and the lower courts in this State have decided that the owner of the surface has such right."

CAN SALVAGE—"In the suburbs of great cities an industry has sprung up having for its object the recovery of the solder used in making and sealing tin cans . . . The furnace is an old soap boiler, into which a few sticks are thrown; the bowl is then filled with cans, a quart of kerosene poured over them and

ignited. The heat developed by the oil is not great enough to attack the tin, but melts the solder, which flows to the bottom of the bowl. The solder recovered from a load of cans averages forty pounds. After this process is completed the tin plate scrap is sold."

RECLAMATION—"The sweepings from manufacturing jewelry establishments, consisting of paper, dust, old crucibles, etc., are packed in barrels and carted to a refinery, where the material is first put into furnaces and burned. . . The value of these sweepings varies greatly, averaging about $5 per barrel, although it has been known to run up as high as $500 per barrel."

SILK—"The classification of silk goods of American manufacture is now practically without limit, embracing every article made in the older silk manufacturing countries, and fully equal to the foreign product in quality of weave, beauty of design, and excellence of finish."

BATTLESHIP—"An ironclad battleship of the first order was launched at . . Philadelphia, on February 28, and was christened the Indiana. She is the largest vessel built thus far on this side of the Atlantic. . . She is of 10,200 tons displacement, having a length of 348 feet, a breadth of 69¼, and a mean draught of 24 . . The engines are twin screw, of the vertical, triple expansion, direct acting, inverted cylinder type, placed in water-tight compartments separated by bulkheads . . . The vessel has a powerful ram bow, and is divided into a great number of watertight compartments by means of longitudinal and transverse bulkheads of 10 and 12 pound plates."

LOCOMOTIVE—"The new monster locomotive of the Mexican Central Railway . . is probably the largest and most powerful locomotive engine now extant. It has been built for special service in drawing freight trains over the heavy grades and curves between Tampico and the city of Mexico . . . The weight of this great machine is 130 tons. . . The high pressure cylinder is 13 inches in diameter and the low pressure 28 inches . . . The boilers . . . carry 180 pounds of steam to the square inch."

TIRES—"The latest adaptation of pneumatic tires is to the wheels of an omnibus which is being tried by the Glasgow Tramway Company at Glasgow, Scotland. The tires are about 3½ inches in diameter, and can withstand a pressure of 187 pounds to the square inch. To guard against any risk of the India rubber being punctured by sharp stones or otherwise, the tires are thoroughly protected by several plies of canvas, with a covering of wire-wove netting. The omnibus is said to be a very comfortable vehicle to ride in."

RAILROAD ARMY—"There is an army of men employed upon the railroads of the United States, an army of 784,000. They are not engaged in idle maneuvers, dress parades, barrack drills, or preparations for warfare, but by their diligence, energy, and toil contribute immensely to the wealth, well being, and development of the country, the interchange of its products, the diffusion of information, and the prompt transportation of vast numbers of passengers, with a remarkably low percentage of casualties."

PULP—"Compared with its predecessor, last year shows a slight decline in the production of wood pulp . . . There are now in Norway eleven sulphite and four sulphate manufactories. Several of these are also connected with paper mills. The exports during 1892 of chemical wood pulp were about 20,000 tons dry, as compared with 17,500 tons in 1891, and about 8,500 tons wet, as compared with 9,500 tons in 1891."

INVENTORS—"Inventors, like most other men, are willing to make money out of their inventions, but many of them go about their work in just the wrong way. . . . They stick to the idea that fame and fortune come only to the inventor who makes a revolution. If such men will only look over history carefully they will find that the great fortunes and fame made of 'revolutionizing' inventions are few and far between, while the greater number of successful inventors have made their fortunes out of things that are small, simple, and capable of general use."

AUTO-PHOTOGRAPHY—"Of all the many uses to which the automatic selling machine has been put, that of taking photographs seems the most remarkable. . . . The operation, so far as relates to the exposure, development, and fixing of the picture, is entirely automatic, and the little picture which the machine throws out, after a momentary washing, appears to be a marked success over previous efforts in this direction."

Personalities in Science

DR. MARY ELIZABETH WARGA

When the United States Office of Education made plans for a nationwide program to train defense workers a year before Pearl Harbor, Dr Warga was the only person, man or woman, chosen to teach spectroscopy Today, after two years, she has taught 250 people to analyze material for shell casings, gun barrels, tank and airplane bodies, and for practically everything else made of metal from fine precision tools to battleship armor

Dr Warga is assistant professor of physics and director of the Co-operative Spectroscopic Laboratory at the University of Pittsburgh In addition to government-sponsored chemists, physicists, and metallurgists, each year she trains 50 university students to read the secrets of the spectrograph Because of this instruction, her trained men and women give an inestimable boost to war production. They work in the laboratories of steel mills and other defense plants, saving untold numbers of man-hours by their immediate recognition of the constituents of liquid steel In a matter of minutes they can pass a batch of steel or reject it for failing to meet government specifications Since they work so fast, the batch can be remedied while still in the molten state, should it be found lacking.

Scientists call the spectroscope the most wonderful scientific instrument in the world It uses the color spectrum as a standard against which it compares the known color for each of the 92 elements in nature. It burns at intense heat a small sample of the material about which the facts are sought. The colors given off during the burning reveal the elements in the sample Each element has its own physical pattern, a grouping of lines too sensitive for the eye to see but visible on photographic plates Adept at "spot" identification of these colors and lines, Dr Warga teaches her war workers to recognize them too They learn what the color and pattern should be Variations reveal defects

Dr Warga has worked with the spectroscope since she was 20 years old and a junior in college Now she is able to tell in a few seconds the composition of anything she submits to the intense heat of its carbon lamp a sample of steel, a particle of food, a drop of blood, or anything else She knows almost at once what it is

Dr Warga became a general in the army of production by way of astronomy The spectroscope was invented to read the composition of the stars and Dr. Warga started with astrophysics and now goes back to labor and industry

An example of Mary Warga's resourcefulness is shown in the way she got herself a job She learned that the Mellon Instiute, affiliate of the University of Pittsburgh was planning a study of air pollution She applied for the post of investigator, and was accepted With her spectroscope she made studies that lasted five years, and which showed that Pittsburgh lost approximately one third of its sunlight through dust in the air

The job came to an end and again she was out of work But at Mellon she came across a large spectroscope lying unused since its purchase in 1912 She was told that if she could rebuild it she could have a job using it. For six months she studied how to rebuild it She read books and consulted scientists She put it in working order and became spectroscopist for the Institute, a job she held for three more years.

Today, Dr. Warga has two spectroscopic laboratories under her direction. Besides the one in the University of Pittsburgh's Department of Physics, she has charge of one in Industrial Hygiene in its School of Medicine. Here studies on certain toxic occupational diseases are being made

HOW NAVAL BATTLES ARE FOUGHT

The Strategy and Tactics of the War at Sea

IF THERE is such a thing as clarifying today's naval strategy, the answer perhaps is: To be ready for anything with everything.

No sooner do we have one type of sea engagement in which the opposing surface craft remain hundreds of miles apart, fighting it out with their aircraft alone, than we have other sea engagements wherein the surface craft slug it out with each other, gun for gun, almost the same as in the Spanish War

Nor should any of us at this time formulate any hard and fast rules as to how the various types of war machinery—air, undersea, and surface—work together under battle conditions For no two sea engagements thus far in this war have been the same

Those who, in past years, have held out for the might of battleships above all else have been right Those who have held out for the might of dive-bombers above all else have been right Those who have held out for the might of carriers, more and more carriers, also have been right The list could continue

In brief, everybody has been right And to prove his theory anyone has but to point for his example to some specific sea engagement. After picking the right one out of the multitude, he can say. "See, I told you, I've always told you. . . ."

The obvious catch in such logic, however, is the ruthless fact that tomorrow's sea battle may approximate something never even dreamed of. or, even if it has been conceived of as a tactical possibility, the conceiving tactician, unless he were at the scene of battle, would be unable to cope with the situation

In the old days, in the days of the theoretical grand battle of fleets, even a youngster, playing with toy vessels on the kitchen floor, could outline the

● Six articles, analyzing the battleships, aircraft carriers, cruisers, destroyers, submarines, and aircraft of the United States Navy, have been published in our issues of May, August, September, October, November, December of 1942. The present article, prepared with the whole-hearted co-operation of the Navy Department, traces the strategy of naval battles as they are fought today. Here are the answers to those who hold for the complete superiority of the battleship, as well as those who place air-power above all else. —*The Editor.* ●

one-time accepted principles of grand fleet meeting grand fleet in the knockout and final combat for control of the seas

Those were the days, when, according to principle, the battlefleet was organized around its biggest, hardest hitting, and most valuable men-of-war —the battleships They would be placed in the center of the battle formation so that the lighter, more maneuverable vessels on the outer fringe might protect them from torpedoes which the battleships, supposedly, would be too heavy and too slow to avoid

AHEAD of the battleships, according to the same established principle, would be the attack force, consisting of heavy cruisers with destroyer escorts The destroyers protected the cruisers from torpedo attack, and the cruisers, in turn, were to block any enemy vessels which crashed through the outer lines.

Behind the main body of the fleet would be a similar force of cruisers and destroyers. They would serve as a rear guard to prevent the enemy from crashing in from behind.

Then, if possible, there would be even a third force of heavy cruisers, or even battleships, together with destroyers. This group, as the youngster playing on the floor would know, was called a support force Its duty was to reinforce any part of the battleline threatened by attack

Nor is this the whole picture of an ideal fleet about to meet a supposedly ideal enemy. Outside all these forces would be a screen of light cruisers and destroyers to protect the battleline as a whole This was called the inner screen, for still farther out, perhaps 40 or 60 miles from the main body of the fleet, steamed still another screen—the outer screen of destroyers and fleet submarines Their mission, so snuggly planned, was to scout for the enemy fleet and intercept any attacking force of the enemy Or, again, their greatest service could have been to meet in daylight any enemy groups close enough to the main fleet to have steamed in and attacked during the hours of darkness.

YES, THE youngster, given his toy vessels, could have arranged it all quite nicely there on the floor Or if the boy were playing in a day when there were such things as toy aircraft carriers to go with his toy fleet, he would have employed the carriers in two possible ways. They might have been placed with the battleships in the center of the fleet, the safest possible position. Or they might take up a position alone, protected only by a destroyer escort, perhaps a hundred miles from the main body of the fleet.

In either case, the theater of operations for the planes themselves would be over the two opposing battlefleets, the dive bombers and torpedo bombers pressing home an attack on the enemy vessels, and the fighters protecting the youngster's own vessels from a similar enemy attack.

The planes would sink or damage the enemy ships, if possible, and would try to break up the formations of the surface vessels and force them to zigzag and slow down. This would enable the rest of the boy's forces to close in so that the outer ring of destroyers

could dash in with a sudden torpedo attack and retreat under cover of a smoke screen.

Soon, then, the two majestic rival fleets would close in sufficiently for the cruiser forces to press home attacks, and for the huge battleships to overwhelm the enemy with a rain of destruction—thereby ending the war.

This, then—on kitchen floor or on paper—was the clashing of fleets as envisioned before actual war came along, in such a distributed way, to prove that there was no such thing as one big grand fleet anymore. At least, not yet.

THE NEAREST, or at least the earliest, resemblance to such a paper perfect engagement in the present war was, perhaps, the meeting between Britain's Mediterranean Fleet under Admiral Sir Andrew Cunningham and a large force of the Italian fleet. This engagement occurred March 28, 1941, and was not entirely surface. Reconnaisance aircraft were the first to report that the Italian fleet, after being in hiding so long, was showing signs of activity. It is now believed that the purpose of the Italian fleet was to keep Admiral Cunningham's forces busy while Axis convoys were rushed to Rommel in Egypt.

But the English had no way of knowing the Italian's plan and were delighted to receive the reconnaisance report that the enemy finally had ventured into the open. To meet the Italian fleet the British sailed out of Alexandria on the 27th. The British force consisted of three sister battleships, *Warspite*, *Barham*, and *Valiant*, the aircraft carrier *Formidable*, and a full complement of cruiser and destroyer forces.

The battleships steamed along in single file, exactly according to Hoyle, so to speak, and with the *Formidable* just astern the flagship *Warspite*. The cruisers and smaller ships were disposed in approximately the classical manner. Early the following morning, reconnaisance planes reported three Italian battleships about 100 miles away, heading eastward, accompanied by several cruisers and destroyer forces—also aligned in the classical manner.

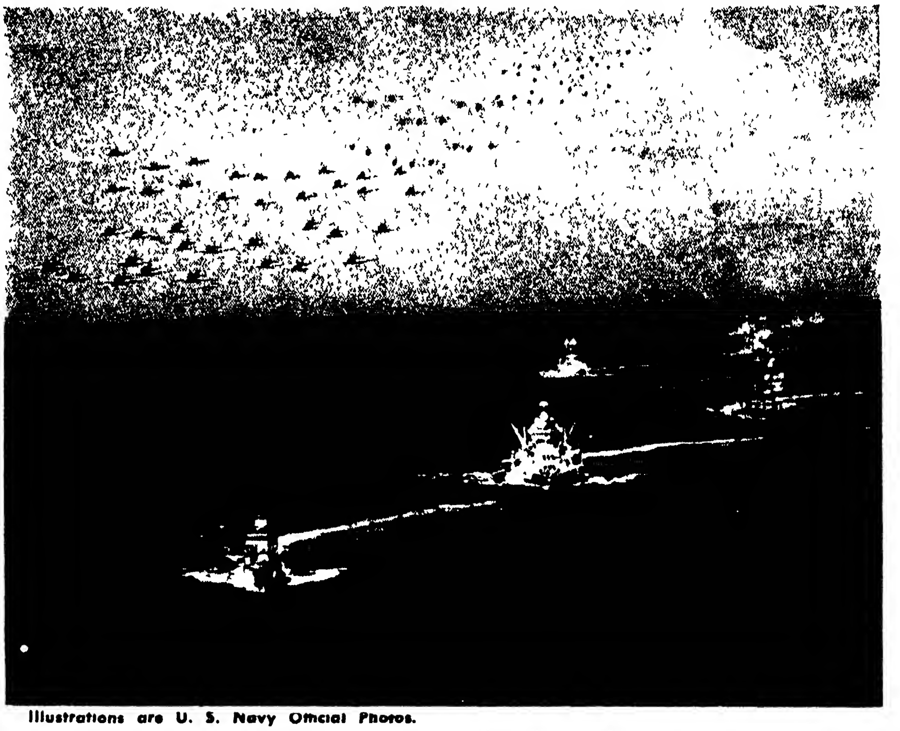
Soon one of the outlying British cruiser squadrons exchanged a few shots with an outlying Italian cruiser formation, and attempted to lure it southward into the path of the British battleships. But the Italians shied away.

Nevertheless, the battle gradually took shape along the best of accepted theories. The two battle lines continued to draw closer until the Italian battleship *Vittorio Veneto* opened fire at extreme range upon British light forces. In retaliation, the *Formidable* launched two squadrons of torpedo bombers which succeeded in getting several hits, cutting the *Veneto's* speed by two thirds and setting her afire.

One plane also hit the cruiser *Pola*, damaging her steering device. The Italians likewise attacked with torpedo planes, but were beaten off. At dusk, the British battleships turned to finish off the *Pola*, but before they reached her, an Italian cruiser squadron, apparently unaware of their proximity in the darkness, and apparently unaware of the rules as well, cut across their path. The *Warspite* opened up at point blank range with her 15-inch guns and seven tons of shells crashed into the *Fiume*, last cruiser of the Italian line. She went up in flames before she could fire a single shot.

Two destroyers escorting the cruisers immediately dashed toward the line of British capital ships and launched torpedoes, but they missed and the Italian destroyers were sunk. Then two more Italian cruisers received the same treatment from the *Valiant* and the *Barham* that the *Fiume* had received from the *Warspite*.

Therewith the battle of Cape Matapan—almost a perfect example of a fleet engagement exactly as the theorists would have it fought—was over and won. Most of the larger Italian men-of-war were either sunk or badly damaged.



Illustrations are U. S. Navy Official Photos.

A battle line, with carrier-based planes

So, with this early example, the theorists certainly had an excuse to presume that the same old manner of winning sea engagements would continue to be the same old manner of winning sea engagements. Maybe they are right, and maybe the battleships, as usual, should be counted on for the kill.

YET IF one does care to figure that way too strongly, especially in this war of strange upsets, it would be better for him to forget or at least not to mention, the battleship *Prince of Wales* and the battle cruiser *Repulse*. No enemy surface craft, it appears, shared in this battle at all, the two great vessels going down off Malaya under the hammering of land-based planes alone.

It was a lesson, to be sure. But a lesson which, since then, has worked both ways; the aftermath occurring not far from Guadalcanal. There the Japs tried it again, this time on an American battleship under command of Capt. Thomas L. Gatch. The Japs, remembering the *Prince of Wales* and the *Repulse*, confidently launched upon this American battleship what is described as "the heaviest air assault ever made on a dreadnought." The first attack (on October 26) was made by 20 enemy dive bombers. All were shot down. Half an hour later, 40 enemy torpedo planes and dive bombers returned to the attack, approaching at the rate of about one every minute. All but one torpedo plane either fell or turned back.

An hour later 24 more Jap torpedo

planes and dive bombers roared at the battleship in a third try. One of the dive bombers did get through, slightly damaging a turret and inflicting Captain Gatch with a neck wound from a bomb splinter. But the score in all was 32 Jap planes downed by automatic anti-aircraft guns and a secondary battery of larger guns. Fighters from an American carrier also answered the challenge.

Anyway, despite their success with the *Prince of Wales* and the *Repulse*, the Japs today certainly cannot be too sure of anything, either. Because planes have taken such an important part in nearly all sea engagements, landings, and the like, the difficulty today, for a fact, is trying to remember some important sea engagement in which planes did not share importantly, at least in the destruction. The celebrated fight with the *Graf Spee*, so early in the war, might be the best example of one such engagement.

The *Graf Spee* was at sea when Germany invaded Poland, and immediately began harrying British merchant shipping off the coast of South America. One of her victims succeeded, on December 2, in sending distress signals before she was silenced, and these were relayed to Commodore H. H. Harwood, in command of the South American Division of the America and West Indies Station of the Royal Navy.

Commodore Harwood was faced with an extraordinary problem. He had only three vessels at his disposal: the 8400-ton *Exeter*, mounting eight-inch guns, and the *Ajax* and *Achilles*, both 7000-tonners and both with only six-inch guns. Opposing him was a much larger, more powerful ship, mounting two turrets of 11-inch guns.

Not only did the *Graf Spee* have greater range, so that she could fire on the British ships before they could close in to their own range, but she could hurl 4700 pounds of metal and explosive in a single broadside, as against a total of only 3136 pounds for the three cruisers combined. In addition, the greater armor of the German ship would enable her to stand more punishment that the smaller vessels.

Contributing to Harwood's problem, too, was the fact that his vessels were scattered over several thousand miles of ocean when he received the distress signal. He had to choose some rendezvous point, but the question was: Where? He knew that the *Graf Spee* would not linger long at the spot of her most recent sinking, for the raider's mission was to sink more merchant ships. The last thing the *Graf Spee* desired was to brush with enemy warships. Reasoning that the German ship might make a run for the River Plate, where there was always a great concentration of shipping, Harwood decided on a point 150 miles east of the Plate's mouth for the rendezvous, and set 7 A.M., December 12th as the time.

The three cruisers met on schedule and began cruising at 14 knots, their captains directed to act "without further orders so as to maintain decisive gun range." On the morning of the 13th the *Graf Spee* was sighted to the starboard and slightly astern of the squadron.

The *Exeter* made a sharp turn at once so as to cut across the battleship's bow and be on her starboard side. The other two ships made a similar turn shortly afterward to take position on her port side, thus forcing the German commander, Captain Langsdorff, to split the fire from his two turrets of 11-inchers. This the German commander did as he opened fire. The *Exeter* replied with eight-inch guns as soon as she was within range, and the other two opened up with their six-inchers a few minutes later.

The German captain, however, was more worried about the *Exeter's* larger guns, and swung both turrets of 11-inchers to bear on her. Immediately he landed a series of destructive hits. But, at the same time, the *Ajax* and *Achilles* were allowed to close their range, opposed only by ragged and inaccurate fire from the German's 5.9-inch batteries.

Two broadsides from the six-inch guns of the cruisers found their mark, putting the *Graf Spee's* fire control apparatus out of commission and killing most of the officers in the fire control tower. Still the two British cruisers closed in, to within about a mile.

The *Graf Spee* was demoralized. The battleship began to lay down a smoke screen, made a 150-degree turn, and began to run.

The British were ready. Working at a killing pace, their engine-room crews had built their speed from 14 up to 28 knots while the battle was raging. They started pursuit, launching the observation plane from the *Ajax* to spot their fire, this is about the only mention ever made of a plane in the battle.

The *Exeter* received two more direct hits. By now two of her three turrets were out of action, her compasses were smashed, she was on fire, and had a seven degree list. But she steamed ahead at full speed, and continued to keep the *Graf Spee* under fire.

The German ship laid a series of smoke screens and changed her course in a frantic effort to escape. Under cover of a smoke screen, she desperately turned on the *Exeter* to try to finish her off, but the accurate fire from the other two cruisers, closing in, again forced the battleship to split her fire.

The two lighter British ships were hit but continued fighting, the *Exeter*, her last gun put out of action by flooding, was forced to turn away. Finally, the cruisers' ammunition was running so low that it might be exhausted if the fight continued until dark. So Harwood chose to break off the battle and simply follow the *Graf Spee* until he might sneak up on her under cover of darkness and perhaps finish her off with torpedoes.

The pocket battleship succeeded in making the River Plate where, as the world knows, she was trapped by other British warships hurried to the spot. And there she was finally scuttled.

Although the sea fight itself, if judged by the whole war, may not have been of decisive importance, nevertheless the fight does remain a superb illustration of British tactics—to close with the enemy, regardless of odds, to use bulldog tactics up close and slug it out.

But, at the same time one rather wonders what would have happened if planes—bomber or torpedo—had been as furiously involved in this engagement as they have been in later ones. For planes do seem to disrupt, by a single lucky hit, the best laid tactical plans of man or war college.

The Battle of Java sea (starting February 26, 1942) may be used as another example of closing in on the enemy in the classical manner, and also as another example of carrying the attack to the enemy, against great odds. The attack was made by a combined force of Dutch, British, and American ships.

On the date mentioned, Admiral Doorman, of the Dutch, received report of a Japanese convoy of 40 transports, protected by divisions of light and heavy cruisers and destroyers. Doorman was ordered to "proceed, search for, and attack the enemy."

Although all the men of his little fleet had been at their action stations for 37 hours without rest and were completely exhausted, Doorman proceeded as ordered, shaping his battle line as he went.

Heading the line were the two British destroyers, *Jupiter* and *Electra*. Next came the Dutch heavy cruiser *De Ruyter*, followed by our old friend the *Exeter*, the American heavy cruiser

Houston, the Australian light cruiser *Perth*, and the Dutch light cruiser *Java*. Following the cruisers came a line of four United States destroyers in single file On the port side of this battleline was a line of four other destroyers.

As the allied force pulled up parallel with the Japanese battleline, it was seen that the latter was composed of two heavy cruisers, followed by six light cruisers Beyond them were two lines of four Japanese destroyers each

Even if the allied force had been fresh and undamaged, it would have been outweighed two to one and heavily outclassed in fire power But to make matters worse, the after turrets of both the *Houston* and the *Exeter* were out of commission

The Japanese heavies opened fire at 25,000 yards, a range at which only 8-inch guns would bear The *Houston* and the *Exeter* returned the fire with their own 8-inchers, setting both the Japanese heavies afire Then Doorman closed in to under 20,000 yards, maintaining the same formation, and the firing began between the cruisers all the way down the line

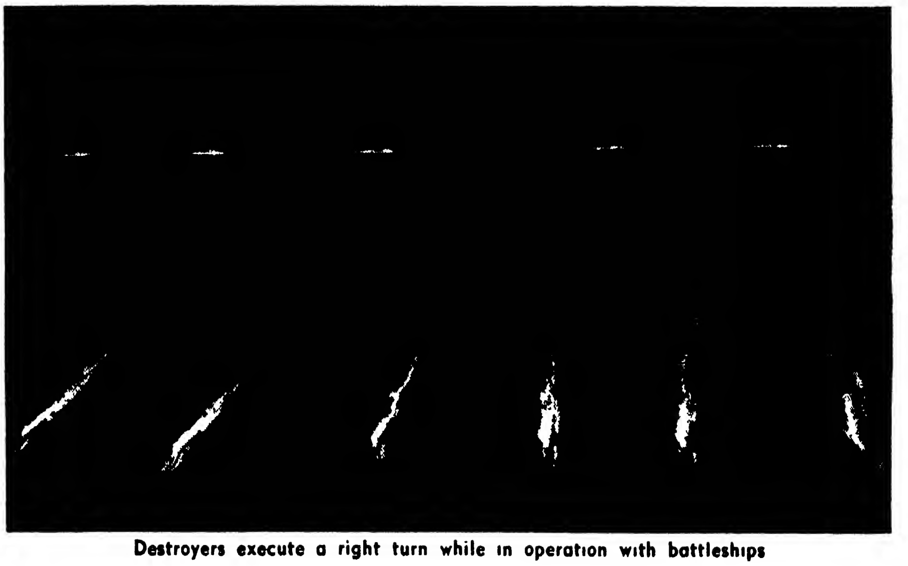
Both sides were hit hard, and the two Japanese heavy cruisers were burning badly At this moment, the Jap cruisers laid down a smoke screen, through which their destroyers wheeled to launch a torpedo attack Before they could begin, the two burning Japanese heavy cruisers dropped out of line, and four of the destroyers turned to screen them The other four continued for the Allied line of battle

The British destroyers *Jupiter* and *Electra*, at the head of that line, turned sharply and dashed into the smoke screen to intercept the attacking Japanese ships They were never seen again The *Perth* and the *Java* then had to shift their fire from the cruisers to the attacking destroyers, enabling the Japanese cruisers to fire more easily The *Exeter* got a bad hit in the fire room, slowing her down, so she turned to port to escape the torpedo attack The *Perth* turned to lay smoke to protect her, leaving the *De Ruyter* and the remaining cruisers so hopelessly outgunned that they had to turn, too

Four of the allied cruisers rushed to screen the wounded *Exeter*, and the four American destroyers covered the general retreat, torpedoing and sinking two of the attacking Jap destroyers

This was the end of the action The Japanese had taken too much punishment themselves to pursue the scattering allied ships.

Despite the tangled outcome of the Battle of Java Sea, students of the classical manner of doing things may find in studying this battle a demonstration of the tactical co-operation of the various kinds of warships Much of it was performed exactly according "to the book" the Japanese heavy cruisers opening fire at the range where their largest guns could be used to the greatest advantage; the Allies closing in until they could use all their guns; the concentration of allied fire on the heaviest Jap units until they are put out of action, the Jap cruiser laying a smoke screen through which the destroyers might dash to attack the larger allied units in retaliation, and finally, the use of the destroyers both to screen larger ships and to try to head off the Japanese destroyer attack



Destroyers execute a right turn while in operation with battleships

At the time of this writing the more important sea engagements in the Solomons can be grouped into five distinct battles, each bearing a name The first of these, already titled the Battle of Savo Island, occurred the night of August 8 9, and marked the first real offensive of the United States in the war

This article being confined to sea-fighting, the concern here is not with the exploits ashore, after the marines had been landed from transports, but with the action at sea preparatory to and during these landings. The engagement also was the first between surface forces in the Solomons

A strong enemy force, seeking to attack our transports and supply ships, was opposed by a screen of our cruisers and destroyers disposed southeast of Savo After a brief but fierce engagement, the Japs changed course and attacked a second screening force northeast of the island A close-range action ensued. We lost the *Canberra*, *Quincy*, *Astoria*, and *Vincennes* The enemy losses remain unknown, but the enemy did fail in its objective because our transports were saved, and our Marines were landed

The great part that aircraft played in this battle, and in the subsequent Solomon Island battles, too, would require a chapter of its own

The second main sea engagement in the Solomons, now labelled the Battle of the Eastern Solomons, occurred August 23-25 This was when the enemy attempted to recapture shore positions Several groups of enemy ships, including transports, approached from the north and northeast They were attacked first by our aircraft, and later by our surface forces The series of running engagements resulted in the withdrawal of the Japs Their losses included damage to one battleship, two carriers, several cruisers, a destroyer, a transport, and four other vessels.

The part that aircraft again played in this battle is best demonstrated by the fact that on the afternoon of August 23 (Washington time), Guadalcanal was attacked by enemy planes, and 21 were shot down against our loss of only three Much the same type of attack occurred two days later when the enemy attacked Guadalcanal with 16 two-motored bombers and 12 Zeros Seven of these bombers were shot down, and also five Zeros against our own loss of one fighter

So, in a report of these sea-engagements or surface engagements, one does find difficulty at times in distinguishing the out and-out air action from the surface action Both types of action obviously go together, the Navy's job being not only to be ready for fleet-against-fleet battles, as previously described, but also the convoying of troops and supplies, harrassing enemy commerce, protecting our coasts from enemy raiders both on the sea

(*Please turn to page* 137)

Industrial Air Control

Compact Survey of Air Conditioning Shows Its Importance on the War Production Front

MARGARET INGELS, M.E.
Engineering Editor, Carrier Corporation

MANY of the mechanisms of modern warfare have become so complex and precise that control of the air is as vitally important in many war industries as it is on the fighting front On the battle line, the outcome of many an action hinges on control of the air as planes engage planes with machine gun bullets and shell fire and rain bombs on key objectives; on the home front—the production front—control of the air, while less dramatic, is equally significant Here the job is one of controlling the air in laboratories, assembly rooms, tool shops, and precision instrument plants where the equipment for our fighting men is being made

Control of the air, actually just another phrase for air conditioning, is a complicated business of far greater importance than the familiar comfort cooling It includes control of the temperature, humidity, cleanliness, and movement of the air. Were it not for the precise art of air conditioning, pioneered a few short decades ago by Dr. Willis H. Carrier, American weapons would not have attained their high degree of effectiveness, nor could they be produced in the astounding numbers that, today, are accepted as run-of-the-mill operation.

Suppose that an airplane instrument should fail at a crucial moment because perspiration on a worker's hand on the home front had caused corrosion, that a torpedo failed to function properly because of excessive moisture in the air during manufacture, that a stick of bombs went wide of its objective as the result of a drop of moisture or a particle of dust in some American war plant thousands of miles away: These are just a few of the possibilities that might occur if American industry did not have available this accurately controlled tool of air conditioning. So widespread has become the use of air conditioning in certain vital war industries, in fact, that it is difficult to imagine the effect of eliminating this important aid to production.

Such a thought opens interesting but disaster-laden possibilities. If there were no such art as air conditioning, many plants could operate only part time, extremely accurate work to close tolerances would become far slower and more difficult; many modern processes could not be carried on at all.

The author

Without control of industrial air, there would be only about five days in an average year when the unaided weather would be suitable for the manufacture of rayon. And this specialized conditioning of the air needed for making rayon fabrics is equally necessary in the manufacture of nylon used in parachutes, powder bags, and for countless other requirements of modern warfare.

Only an almost impossible Weather Bureau forecast of "Temperature Unchanged" would point to suitable air conditions for technicians making precision gages, since these instruments are accurate only when manufactured and calibrated at constant temperature. A sharp rise or fall of the thermometer, if not offset by man-made weather, would serve to negate the most accurate work of skilled craftsmen. An extended period of "Cool and Dry" weather would facilitate the production of precision instruments where work to close tolerances is required, but obviously the demands of war production cannot wait on the vagaries of the elements.

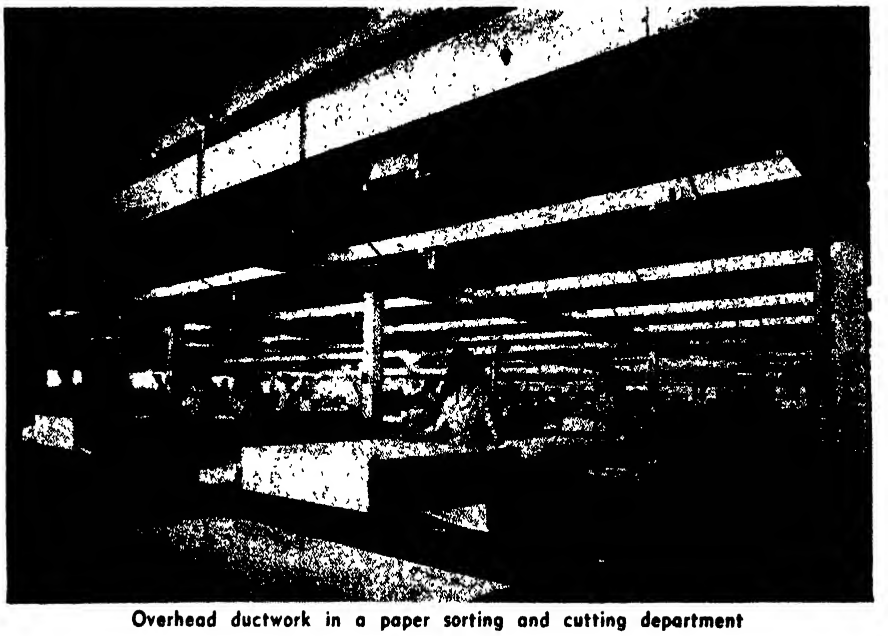
Today, therefore, more than 200 different industries utilize as a production tool one or more of the factors which go to make up modern air conditioning. And such control of the air, as has been briefly shown, is playing a vital role in the nation's war production.

School boys and girls learn in physics classes that objects take on the temperature of the air surrounding them But the significance of this to war production is not always recognized Some objects come to temperature equilibrium very quickly, with little physical change, while others, especially those made of metals, take a long time to reach room temperature and will measurably expand or contract in doing so For this reason it is necessary to hold room temperature constant when close measurements are to be made and where work to extremely close tolerances is to be undertaken Rooms used for gage calibration and measurement of precision instruments are air conditioned to assure constant temperature Thus, a precision machine part made in a Texas factory may be fitted accurately with a companion piece made in Massachusetts If the temperature of the parts is not the same when measured, they will not fit together in the final assembly; differences in temperatures produce the same effect as taking the measurements inaccurately.

A familiar example of the effect of one of man's concessions to the effects of temperature changes is the "clankity clank" of railroad car wheels as they pass over the space between rails, left to allow for expansion and contraction of the rails as the temperature changes. But no such simple solution may be used where work of great precision is required—as in the case of bombsights, range finders, and other close-tolerance

instruments of war. Instead of fractions of an inch, measurements for such precision instruments are made in "light rings," which means that accuracy is sometimes held within tolerances of 6/1,000,000 of an inch. Such close measurements can be maintained only in conditioned air where temperatures are held at specified levels at all times.

Temperature control is also required for testing radios to be used in military airplanes to be sure that they will meet the rigors of field service. In some of the tests, however, it is not a question of holding temperature constant but, rather, of changing it at the rate of change that occurs when the plane is in use. The reason for this is not hard to discover. The radio in a plane leaving the ground in the tropics may be at a temperature of 120 degrees. As the plane climbs, the temperature drops, often dipping as low as 60 degrees below zero. Yet, throughout wide and rapidly changing temperature ranges, the radio must function perfectly. To build radios that will react to fast and extreme weather changes, laboratories use air conditioning to simulate conditions ranging from tropic heat to subzero temperatures of high altitudes, changing from one to the other at a rate approximating actual flying conditions.



Overhead ductwork in a paper sorting and cutting department

Just as constant temperatures are called for in precision work and controlled fluctuation of temperatures serve in testing radio and various equipment, so other war production processes find essential one of the several machines developed for air conditioning at Carrier's huge plant—low temperature refrigeration. For example, the manufacture of one type of synthetic rubber requires a temperature of minus 98 degrees, Fahrenheit, during processing. Liquification of chlorine also calls for temperatures well below zero. And a low and constant temperature in blood banks makes it possible to hold large quantities of blood plasma or whole blood in readiness at all times, the coolness making possible the preservation of the original quality.

Coating photographic films, manufacturing certain plastics, processing rubber, chemicals, and pharmaceuticals—these are some war jobs that utilize low temperature air conditioning. But not all conditioned air is cold air. If someone were to tell you that "hot air" would help win the war, an argument involving much of that very commodity might ensue. But the statement is true, nonetheless. Warm, dry air facilitates powder drying in ordnance plants, makes possible scientific food dehydration, and serves as would nothing else in numerous other processes including smoking of meat, leather drying, and flour milling.

Moisture in the air, another phase of air control, can be both friend and foe of war production. The finely machined parts of precision instruments, for example, are highly susceptible to both corrosion and rust. A fingerprint from the moist hands of a worker may mar the finished surface or cause corrosion after the instrument is completed. An over-abundance of moisture in the air condensing on a metal part may be the cause of rust which will soon destroy the accuracy of fine mechanisms completely. Air conditioning guards against such dangers by dehumidifying the air in work shops, assembly rooms, and storage spaces.

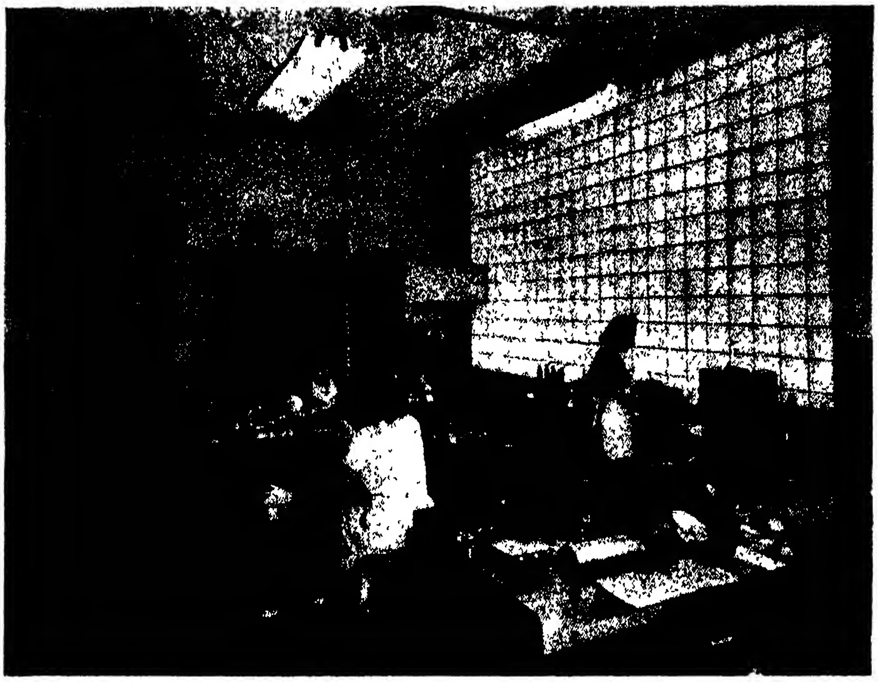
In some processes, damp air means slowed up production and even possible shut down. Many plastics are processed in air that is dehumidified because moist air makes the sheets "tacky" and difficult to handle. Concentrated foods, such as bouillon cubes, are prepared in dehumidified air because high humidities slow up production and affect quality. Many drugs are manufactured in dried air because an excess of moisture would ruin the value of the medicines, compounding these same drugs is a hit-and-miss proposition if they are allowed to absorb varying and unknown amounts of moisture, making basic weights of the ingredients questionable.

On the reverse of this last situation are to be found some industries in which lack of moisture in the air makes efficient production impossible. In dry air indoors during cold winter weather, "static" causes a shock when a person touches a metal doorknob or wall switch. Under similar conditions, static collects on fibers in textile mills or on paper in printing plants. The result may not be an electrical shock that can be felt, but production schedules frequently cannot be maintained when static is present: Threads become fuzzy and break often; fabrics cannot be woven evenly; papers stick and do not feed uniformly into the presses. In plants where static causes trouble the air is humidified—moisture is added—when the want of moisture in the air makes a difference in production.

Textile mills were among the first to adopt the tool of air conditioning. Control of indoor weather made possible the high-speed manufacture and tremendous growth of rayon. Nylon requires a low temperature during processing. Fortunately, long use of controlled temperatures and relative humidity in textile mills has made possible the rapid development of synthetic fabrics that are now being used for parachutes, powder bags, and clothing for our Armed Forces.

In the printing of maps and charts, often in many colors, conditioned air contributes largely to an accuracy which would be impossible if this industrial tool were not used in press and paper storage rooms. This is because variations in temperature and humidity may cause paper to expand or contract between the times when the different inks are applied.

Some industrial operations must be done in dust-free air, since a particle of dust may ruin the product. Clean air is required in the assembly of precision



Wall and floor duct installation in a precision tool plant

instruments; a dust particle in the works could seriously impair the accuracy of the gage, bombsight, or range finder. Just as watches cease to be good time keepers if not clean, so do other precision instruments lack accuracy under the same conditions. Optical lenses, built up of several elements of carefully ground glass, are virtually valueless if dirt is permitted to fall on the inner surfaces during assembly

Besides being used as a production tool, air conditioning serves in many vital places outside of the factory. "Cold banks," that provide locker or food storage in rural communities, preserve the food in low temperature air conditioning. Men in the services are equipped and fed with the aid of conditioned air For example, fur coats for fliers are kept in the best state of preservation in low-temperature air conditioned vaults, food refrigeration on ships and in camps maintains meat and other foodstuff at top quality Mobile photographic laboratories of the Army are equipped with air conditioning to assure accurate and speedy photographic work in the field. Parachutes are made to last longer by being stored, whenever possible, in conditioned air to prevent mildew or other deteriorating effects which might occur in storage when the air is not controlled.

So universal is the use of air conditioning as a production tool, and so great are its uses in preserving manufactured goods, that it is difficult to imagine industrial America without air conditioning. In many respects war production as we now know it would not be possible were it not for air conditioning; it is a vital tool in helping industry to produce the materials of war needed to preserve the American way of life. It is not, as some people still believe, a mere means to comfort.

• • •

PAPER

For Many Wrapping Purposes, Is Stretchable

Development of a new application for creped paper has been made by the Arkell Safety Bag Company This new paper, designed to take the place of scarce textiles in wrapping and baling materials for shipment, can be stretched in all directions, providing a characteristic which is claimed to protect the paper against tearing in ordinary wrapping services. This new paper is available in various grades and weights and in roll or sheet form

SHIP CLEANER

Can Remove Oil In Presence of Salt Water

Merchant ships, battleships, tankers —any ships which have been damaged in battle, in fact—are usually badly contaminated with heavy, black, tarry bunker oil when received in repair yards. This tar-like oil penetrates into machinery and instruments and presents a serious removal problem, which is complicated by the fact that the oil is also associated with salt water, which breaks down ordinary cleaners.

This unusual and pressing problem has recently been solved by the use of Gunk P-96, a concentrated and self emulsifying degreasing solvent developed by the Curran Corporation This product can dissolve, emulsify, and remove heavy concentrations of fuel oil in the presence of salt water.

It is claimed that the action of Gunk P-96 is so thorough that all traces of oil are made water soluble and need only be sluiced with a water hose to rinse and decontaminate large areas such as the hold of a ship.

It is also stated that degreased surfaces so provided are particularly suitable for the application of red lead

• • •

SURFACES—Paints have been formulated which can be applied under all conditions under which a man can work—some paint can be applied at temperatures as low as zero degrees, Fahrenheit, on frosty or icy surfaces, and can also be applied when the temperature is as high as 130 degrees, Fahrenheit.

• • •

GENERATOR "WATCHMAN"

Detects and Records Vibrations In Rotating Shafts

An automatic electrical "watchman" the size of a large box camera has been developed by a Pittsburgh research engineer to jot down a warning in red ink when it detects vibrations that might eventually cripple a power-producing machine Harry G Werner, "machine-quake" expert at the Westinghouse Research Laboratories, devised the instrument—a midget-sized generator of electricity—to measure in thousandths of an inch the slightest tremors in the spinning shafts of turbo-generators. By discov-

Adjusting an automatic "watchman"

ering quivers in shafts turning at 3600 revolutions a minute and recording a warning, the detector provides a perpetual diagnosis of giant power-house machines

Like a business chart, the vibration record shows month after month how a hard-driven steel shaft is performing "The line usually stays at a steady level, registering normal balance," Mr Werner explains, "but in rare instances the line deviates from its steady course warning that a vibration has developed That deviation tells a power plant operator that a minor adjustment is needed to eliminate the unbalance, remove the resulting vibration, and prevent a possible breakdown."

Mr Werner's vibration detector consists of a babbit-tipped rod that touches a revolving shaft; a miniature generator rated at about one millionth of a watt, an amplifier to step up the current to two or three watts; and a recorder that pens a vibration "curve" Vibration in the shaft bounces the pencil-shaped rod up and down. A coil attached to the upper end of the rod moves back and forth inside an electromagnet. This action generates a tiny amount of electricity that travels to the amplifier where it is stepped up enough to move a mechanical pen that marks down a record of the vibration

The slightest quiver in a silently-spinning shaft is thus "felt" and recorded by the automatic instrument Change in intensity of vibration is determined by the deviation from a straight line penned on a paper chart moving through the recorder

• • •

STRATEGIC—In 1921 Government officials listed 42 strategic materials, vital to war, which had to be imported, either wholly or partially. Thanks in part to chemistry, metallurgy, and their related sciences only 15 are on the list now.

• • •

WOOD ARCHES

Advantageously Used Instead of Steel

Tons of steel were saved in the construction of the recently-built USHA Recreation Center at Bremerton, Washington, by specifying the use of wood-and-glue laminated arches. The six arches stretch 71 feet from foot to foot and each weighs two tons

In constructing these arches the fabricators used 26,000 board feet of dimension lumber, 1590 pounds of Laucks casein glue and 10 gallons of Rez, a synthetic resin sealer. The arches were constructed in Seattle and were transported by logging truck to the site. They were built in two sections and were joined together in the center.

Wood-and-glue arches are said to be superior to corresponding structural members of steel in many ways Laminated beams such as these are particularly adapted to this type of construction because they are easy to handle, meet all structural requirements, and while steel melts and buckles in the extreme heat of a fire, laminated wood will char and provide a much longer fire-resistance period

• • •

HIGH-OCTANE—The United States is the world's largest producer of high-octane super-aviation gasoline. Present-day production figures are secret, but a year ago the output here had been set at the rate of 55 million barrels a year.

• • •

GAGE BLOCKS

Reclaimed by Controlled Plating Process

A controllable chrome-plating process has been developed for reclaiming precision gage blocks worn to below required accuracies. The method by which the old blocks are built up is stated to give them five times the life as when they were new

The three-step reclaiming process is, briefly, as follows: First, the blocks are lapped 0.0002 inch undersize Then an even coating of chrome plate 0.00015 inch to 0.0002 inch thick is applied to each of two working surfaces, making the blocks from 0.0001 to 0.0002 inch oversize. In the third step, the blocks are lapped to size

They are checked for size and parallelism on a Pratt and Whitney-General Electric electrolimit gage, and for flatness on an optical flat.

Maximum tolerance over or under the required size is 0.000005 of an inch (five millionths of an inch). The average error is no more than one thousandth the thickness of a human hair. The blocks are checked periodically with a master set to make sure they are up to standard

An electrolimit gage is used to check gage blocks for size and parallelism

DIAMOND DUST

Now Being Recovered In Half Former Time

Pulverized diamonds are used to perform one of war industry's "hardest" jobs, that of polishing tungsten carbide dies to a degree of smoothness which eliminates much friction. Diamond dust is the best substance for polishing tungsten carbide, one of the hardest compounds yet devised by science. Dies made of this compound are used in drawing large size copper wire.

A small electric furnace is part of the equipment for diamond-dust recovery

Diamond dust may be used over and over again, but recovery is a problem During polishing, the dust falls into a receptacle with oil, tungsten carbide particles, and bits of cloth. The recovery ordinary requires large amounts of acids which destroy everything but the diamond dust, but a greatly simplified method, recently devised, requires only small amounts of chemicals and the process can be completed by technicians in half the time formerly required

PLASTIC BEARINGS

Self-Lubricated With Fruit Juice

Large rotary fruit-juice extractors, capable of turning out 200 gallons of citrus juice per hour, now depend on self-lubricating bearings of Lucite methyl methacrylate resin to keep going in wartime. Faced with a shortage of bronze bearings, one machinery manufacturer, after several months of exhaustive trials with new materials, found that, in addition to outwearing other types several times, bearings fabricated of "Lucite" were actually

Propeller-blade shank being rapidly heated by induction

lubricated by contact with citrus juices and periodic steam baths—two things that always shortened the life of bronze bearings. Du Pont chemists have been advised that the new bearings are equally resistant to orange, grapefruit, and lemon juices "Lucite" is now on high priority—available for only the most essential uses

• • •

HORSEPOWER — American firms now engaged in production of air-cooled and liquid-cooled aircraft engines are turning out more horsepower every 15 days than was produced here during the entire period of World War I.

• • •

PROP BLADES

Production Speeded by Induction Heating

HEATING an airplane propeller-blade shank for two important forming operations in approximately one-fifth the time formerly required, is said to have resulted in one of the most time-saving procedures to be adopted in warplane production. The shank is heated by the Tocco process of heating by electrical induction, a method originated by Ohio Crankshaft Company.

In the new process, the shank of the hollow steel propeller blade is first heated, preparatory to swaging, in a 100 kilowatt machine, which raises its temperature to approximately 1700 degrees, Fahrenheit, in 150 seconds.

When the correct temperature is reached, the operator hooks the blade on an overhead spring balance crane and conveys it to a huge National forging machine, capable of producing a 27-ton pressure, where it is swaged into a true cylindrical shape.

At the completion of the swaging operation, the blade passes through two welding processes, a thorough inspection, and a lathe machining operation before it is again mounted on the movable rack and heated a second time for 210 seconds to a temperature of about 2200 degrees, Fahrenheit.

When the proper heating is attained, the overhead crane again conveys the heated piece to the adjacent upsetting equipment in a few seconds. The upsetting operation consists of forming the heated shank in a three-pass set of dies to increase the wall thickness of the shank from .520 inches to approximately 13/16 inch, and to decrease the length of the shank area from 12-5/8 inches to 9-3/16 inches.

Prior to the adoption of the induction heating principle, the blade shanks were heated by means of gas furnaces. Fifteen minutes were required for heating to the desired temperature, and color of the heated work was the only way in which the operator could judge whether the correct temperature had been reached.

REVERSE SYNTHESIS

Nylon Is Reverted to Original Chemicals

ONE of the most interesting new projects developed in the Du Pont Nylon Research Laboratory is in connection with the nylon salvage program. This was undertaken because of the urgent need for more nylon for government use. The high-pressure synthesis equipment which makes nylon chemicals from coal, air, and water is already taxed to capacity, and to make additional equipment would require large amounts of strategic metals needed for airplanes, ships and ordnance. The logical alternative was to salvage nylon scrap and make new nylon of it

The dyed nylon material, including the stockings which women are now turning in at stores and other collection depots, is subjected to complicated treatments. They are, in effect, chemically "unraveled" until the original two starting chemicals from which they were made—adipic acid and hexamethylene-diamine—are obtained.

First step is to boil the stockings in strong hydrolyzing agent. In a laboratory demonstration this is done in a glass flask, to which is attached a reflux condenser; on a plant scale it is carried out in a lead-lined vessel. By the end of the first hour of boiling the stockings have completely disappeared and the vessel contains only a dark brown solution. A precipitate forms on cooling.

Filtering through a glass fabric separates the precipitate, which contains the adipic acid, from the filtrate, containing the diamine.

Each of the two components is now purified. The adipic acid, which is a powder and in the unpurified form may be any color depending on the amount of impurities present, is redissolved and recrystallized and is then treated with decolorizing agents These steps

Nylon reversion on a laboratory scale

yield a very pure final product. The diamine solution is neutralized by addition of lime, which produces a precipitate of calcium sulfate. The mother liquor is drawn off and the water distilled off to leave the diamine. The diamine, which has a higher boiling point than water, is now distilled and it condenses as a colorless liquid, which becomes crystalline on cooling. The "reverse synthesis" of a stocking into its chemical components is now complete.

INDUSTRIAL TRENDS

WHAT TO PUT IT IN

THE container industry—frequently thought of as made up chiefly of producers of glass and tin containers—is in such a state of flux at present that almost any outcome can be anticipated, and with some basis of reason. Hence it is of interest to scan some of the present and near-past happenings, with a view toward watching future events and interpreting them in terms of trends.

A bit of history will help to shape up the whole situation Scarcely possible does it seem that bottles have been made in huge quantities only during the past generation Before 1905, all bottles were made by hand—or, rather, by mouth Then came the invention that led to the perfection of bottle-making machines, and bottles became both plentiful and cheap. Long before that, however, the can manufacturers had been making good use of automatic machinery for high speed production of sheet-metal containers

Once the bottle manufacturers got started, they opened new fields for their products, and during recent years have penetrated deeply into territory formerly considered as the private property of the can makers. Back and forth went the balance, most recent and famous of the swings being the virtual capture of the beer field by the can manufacturers, only to have much of the business retaken by the glass men with containers for the beverage which held all of the advantages of the can and could be tagged with the slogan: "Beer is better in bottles."

But it is no part of our purpose here to hold forth on the accuracy of advertising slogans, even when concerned with the amber fluid that quenches many a thirst. The war put a temporary end to the beer can, and to tin-plate containers in many other fields. At the moment it appears that some of the stress which necessitated this ending may be relieved by improvements in the sheet-steel situation and by an increased supply of tin, but even these bright spots do not indicate any possibility of unrestricted tin-can production before the end of the war. It is possible, however, that there may be some relief in the matter of sheet-metal containers that do not require tin-plate. This would include such products as paints and dry materials that need the protection of a metal container for one reason or another, but do not need the corrosion-resistance of tin.

In the meantime, glass has been progressing favorably in many spheres of packaging. Light-weight, strong glass containers, reported previously in these pages, have taken over much of the tin-can business, and probably will take over much more, especially in the food container field Glass has the advantage of being made of non-critical materials, in which phase it leads many other products in that it can meet extremely large demands, provided that labor is available.

But all is not sweetness and light for the glass container manufacturers. Research on fiber board, plastics, synthetic rubbers of various kinds, and other possibilities in the packaging industry have revealed many new ways of making containers out of materials other than glass and metal. Then, too, "styles" in many things that require containers are changing, making necessary corresponding changes in the containers themselves. Dehydrated foods are one example, and an example that is going to have far-reaching effects on our shopping and eating habits by the end of the war, if not before. Many foods that can be successfully dehydrated and "de-bulked" were formerly packed in tin or glass, in their natural state. Now, devoid of water and often compressed further to decrease their physical volume, these same foods can be wrapped in water-proof paper, synthetic film, or other covering that will afford whatever protection is needed from deteriorating factors.

Then there are the frosted foods which, while not "dry" in the accepted sense of the word, nor de-bulked, do not require the protection of a tin can or glass jar. Here, again, a wrapping of some sort is the only protection needed, so long as the food is kept at the required temperature, and once more the glass and metal container manufacturers lose an old customer or a potential new one

Of course, metal-container manufacturers have all the business they can handle at the present time, either making cans for food and other products on a restricted basis, or engaged in the manufacture of one kind or another of war materials The glass companies are doing all right, too But there is a day coming—and it is to be hoped that it is not too far in the future—when the military war is over and the war of containers starts once more Then it will be more than just glass *versus* metal; the know-how piling up in other fields will be released and the fight will be on!

UP-AND-COMING POWDER METALLURGY

POWDER metallurgy, dealt with in detail in past issues of Scientific American, is making a big place (exact size maintained as a military secret) for itself in many present day industries This definite and highly important trend has been so clearly and patly put in *The Research Viewpoint* of Gustavus J Esselen, Inc, that we turn the rest of this page over to the editor of that recondite reporter of industry's changing scene, and quote:

" . . The process is more than 100 years old, but has made especially rapid strides in the past few years, and is creating a minor revolution in metallurgy

". . . It was in 1829 . that finely divided platinum was pressed and sintered into solid ingots. Later the technique was used to make finished products from tungsten, molybdenum, and other metals with melting points so high that they could not be handled by ordinary molding methods

"The next step was the production of high-speed cutting materials such as the hard cemented-carbides, some of which could never be made by any other method.

"The trend suddenly took another direction when the powdered metal technique was applied to materials that could be and always had been molded In some instances more intricate shapes, with closer tolerances, were obtained In others the production of scrap was eliminated. And what interested industry even more, costs were lowered on quantity production.

"The latest development, announced before the war made all technological progress secret information, was the alloying of metals by mixing mixing two or more alloys in powder form. This is known as diffusion alloying.

"When war restraints are removed, it looks as though there might be a mad scramble among materials, with plastics, wood, glass, metals, and metal alloys competing with one another. As each one finds its place of maximum economic usefulness it is likely that powder metallurgy will become one of the standard processes contributing to a more efficient post-war world."

—*The Editors*

Highways to Strategic Materials

Completed Portions of Pan-American Highway Can Help the United Nations' War Effort

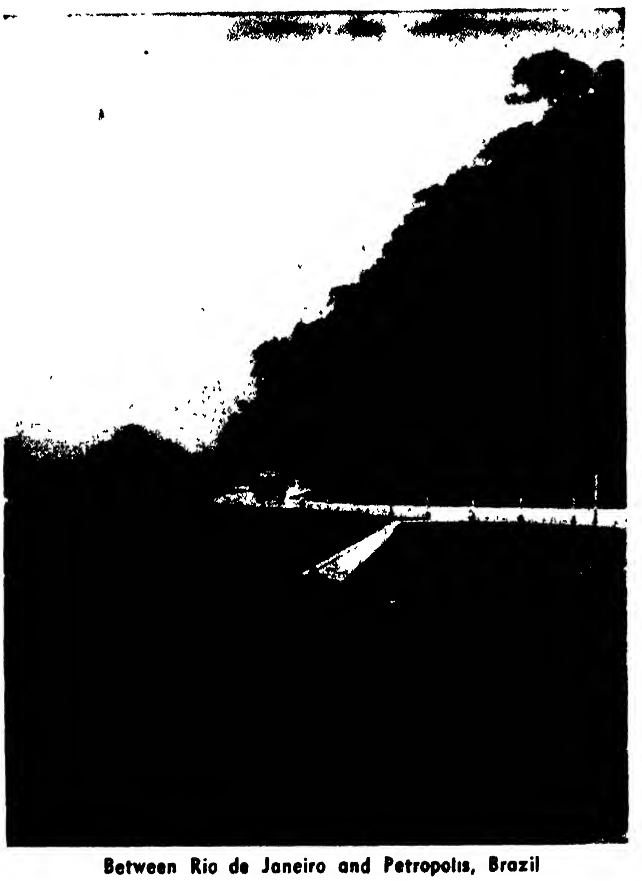
EDWIN W. JAMES
Chief, Inter-American Regional Office, United States Public Roads Administration

THE construction of the Pan-American Highway is a monument to the co-operative spirit of the Western Hemisphere republics, in sharp contrast to the holocaust of destruction now consuming the social and economic fabric of the Eastern Hemisphere. The universal shortage of ship transportation has increased the importance of the Pan-American Highway as a potentially vital factor, not only in the "Battle of Supply Lines," but also in the "Battle for Raw Materials," so essential to our increased war production South America is veritably a storehouse of strategic materials for the great munition industries of the Arsenal of Democracy, and is now more important than ever before as a source of strategic materials formerly obtained from the Far East

The Pan-American Highway System has been under construction for almost 19 years. When it is completed, nearly half a billion dollars will have been expended on it. Construction and improvements of this highway system are continuing today throughout the Americas

For the internal movement of materials in South America there already exist various railroad, air, and river shipping facilities Others which have been proposed or are under construction can be coördinated with the Pan-American Highway. The course of the highway has been strategically laid out so that there are now convenient connections with other forms of transportation.

Highway transportation has figured very prominently in this world crisis. Our Government has recognized the importance of highway tranportation for the movement of materials by granting large loans and appropriations to the other American republics, totaling between 85 and 95 millions of dollars, for the building of the Pan-American Highway through Central and South America. The same objectives are involved in the recent decisions to rush a "pioneer road" from the Mexican-Guatemalan border to Panama City, soon to be linked with the Mexican railway system leading north to the United States border, and to rush to completion the Canadian-Alaskan Highway to make it available for motor transportation for defensive as well as offensive operations. But even these loans and appropriations may be inadequate if speedier construction is wanted.



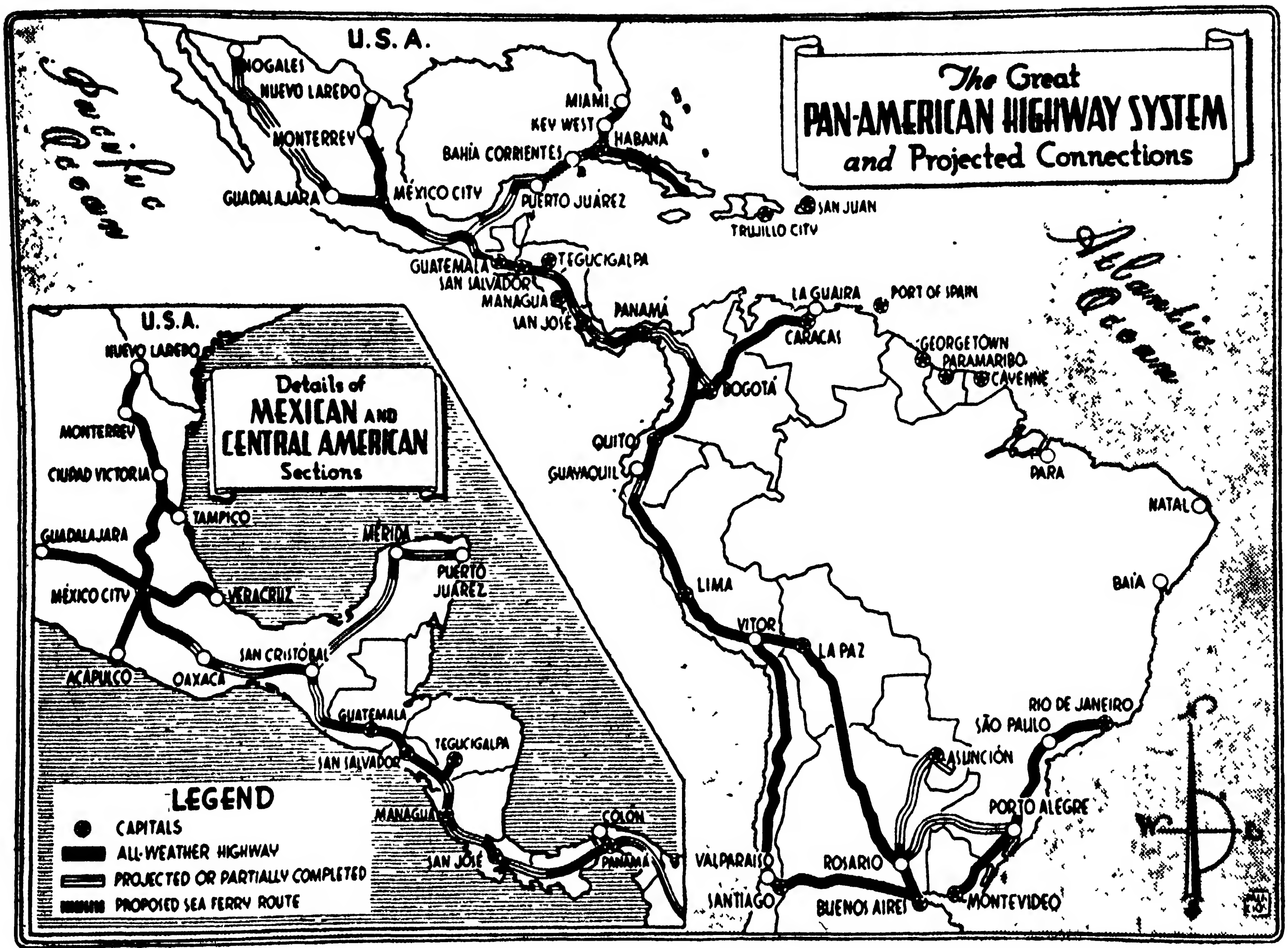
Between Rio de Janeiro and Petropolis, Brazil

The wisdom of a planned international highway system as a basic part of our war program has been dramatically exemplified by China's Burma Road over which has moved strategic materials. Reports indicated that a large percentage of the truckloads consisted of fuel—there being few sources of gasoline supply on the road. Such trucking of fuel would not be necessary along the Pan-American Highway System, since some fuel facilities are now available and gasoline depots could readily be established.

Ships still are the principal means of moving commodities in inter-American trade. Therein is the crux of the inter-American transportation problem It is the long sea distance which makes this menace to our shipping so crucial. If transportation between the Americas over the long sea routes can be sharply reduced and if, at the same time, a continuous flow of essential supplies can be maintained, we are on the way to a solution of the problem.

Shipping distance from Buenos Aires, Argentina, to New York is 5871 nautical miles, if ships follow the normal peacetime shipping lanes around the north eastern hump of Brazil, and then sail in a straight course in the general direction of Cape Hatteras and thence to New York. The usual freight ship passage during peacetime over this route requires 24 days and often more. A major portion of the trip is in the South and North Atlantic Ocean, where the incidence of ship sinkings has been highest, including sinkings of vessels of South and Central American registry. A part of the voyage from Trinidad north is made in secondary naval and aerial patrol zones Through a greater part of the trip, ships do not have the primary protection of the Army or Navy patrols except at the time ships are about to enter waters adjacent to ports of destination in the United States.

Obviously there is a great advantage in routing shipping over the Caribbean Sea and the Gulf of Mexico. Not only is the sea route shortened, but the Gulf and Caribbean region is already under the vigilant eyes of Army and Navy, because of its proximity to the Panama Canal. The concentration of the major part of inter-American transportation in this area would also permit concentration of Army and Navy protective units in this region. Thus protection will be in-



Economic importance of the Pan-American Highway System can readily be seen from this sketch map

creased in proportion to the shortening of the dangerous sea distance

In weighing alternative combinations of land and water routes, it is the South American section of the Pan-American Highway with which we are at present concerned Except for about 2000 miles of continuously surfaced roads in Mexico, the 3500 miles of the North American section of the Pan-American Highway (known as the Inter-American Highway north of the Panama-Colombia border) is not being considered, as that section is still under construction. Some intermediate sections are completed, but will not be continuously connected until June, 1943 Approximately 300 miles of territory in southern Panama and northern Colombia are still only semi-explored

The South American section of the Pan-American Highway between La Guaira, Venezuela, and Rio de Janeiro, Brazil, is about 8200 miles long, following for the most part the Pacific Coast through Colombia, Ecuador, and Peru, and continuing southeast through Bolivia and Argentina and thence northward along the Atlantic Coast through Uruguay and Brazil.

The Pan-American Highway's completed and projected routes are traced on the accompanying map Reports reaching the Public Roads Administration as of August, 1941, indicated that the highway in South America was 76 1 percent finished for "all weather" driving—which means all-year 'round An additional 20 3 percent is "dry weather" road, which can be used six months during the year, bringing the total of useful highway to 96 4 percent for at least six months in the year During the past year additional construction and improvements probably have moved this last figure up to about 98 percent.

FROM April to November, in the 12,600-foot Uspallata Pass in the Andes Mountains, at the border of Chile and Argentina, winter snows accumulate and prevent normal movement of wheeled traffic between the two countries for about six months of the year If increased traffic warrants it, snowplows could keep this road open all year. The map shows the alternate central route north of Buenos Aires, Argentina, to La Paz, Bolivia, connecting with the western branch of the Pan-American Highway to Vitor, Peru This route could be utilized to service Argentina, Uruguay, Paraguay, Bolivia, and portions of southern Brazil during the winter months, so that there can be free movement of vehicles over the highway all during the year

Truck transportation over the Pan-American Highway is expected to be a principal feature of future trade among the other Americas Trade among the American republics is more important than ever before now that they are cut off from many foreign markets Even if the present rate of shipping could be maintained, which is doubtful, normal requirements are not being met A plan to supplement shipping by utilizing trucking over the highway for transportation to the United States of vital strategic supplies would be an important step in providing materials for urgent production of military weapons as well as maintaining South America's economy.

Recent reports from Peru indicate that plans are being considered to solve local transportation problems engendered through the shortage of shipping by using truck convoys over the Pan-American Highway to haul goods from southern to northern Peru, over a distance of about 1000 miles. These plans propose to accumulate

cargoes in northern Peru and thus save a thousand miles of ship movements.

The question may be raised as to whether necessary supplies and service facilities exist in South America to provide for a large-scale, long-haul trucking movement. There is oil in Venezuela, Colombia, Peru, and Argentina; Venezuela is the second largest oil producer in the world.

There is rubber in Brazil, Colombia, Bolivia, Ecuador, Peru, and Venezuela. There are 12 tire factories in South America. Recently, United States government agencies have sent many technicians to South America to stimulate increased production. Forty thousand tons of crude rubber annually is expected to be produced in the other American republics by 1943, with progressive increases each year thereafter.

As to other facilities: Every part of the highway, where constructed, is now being used for inter- and intra-American trucking and bus travel, although up to the present it has not been used extensively for the transportation of strategic materials to the United States, except for limited quantities coming from Mexico. The Mexican section of the Pan-American Highway and other Mexican national and auxiliary highways provide a continuous system of about 2000 miles of surfaced roads directly connected with those of the United States.

Even though we assume that motor transport costs exceed wartime shipping costs by a considerable margin, the fact that we have at present insufficient shipping at any cost to fulfill our needs should eliminate this factor as a basic consideration. Such cost differences as exist, when measured by United States prices, may be substantially reduced by the lower wage scales prevailing in most South American countries and the added economy of operation of Diesel-motored trucks.

As a proposed partial solution, a general movement of critical and strategic materials could emanate from Argentina and southern Brazil and accumulate westward through Chile, and northward through Bolivia, Peru, Ecuador, Colombia, and Venezuela, toward seaports situated on the Caribbean Sea and the port of Buenaventura on the west coast of Colombia, on the Pacific Ocean.

Secondary roads, airports, and railways are built in and adjacent to this region and around the ports of Maracaibo and Puerto Cabello in Venezuela, and Barranquilla, Cartagena, and Santa Marta in Colombia. At these "ports of accumulation" there already are storage warehouse facilities and more could quickly be built. Colombia's own road program includes improvement and extension of secondary roads in this area. Another important link, which is nearing completion, is a new highway which will connect Cali and Palmira, Colombia, on the Pan-American Highway, with the port of Buenaventura on the West Coast.

Progress on a road construction project in Costa Rica

Peru and Bolivia, too, are stepping up auxiliary road construction. Nearing completion is a 350-mile highway which will eventually link Lima, Peru, with its eastern empire across the Andes to Tingo Maria, site of a new agricultural experiment station.

From the South American Caribbean ports shipments could be made to the United States. This routing would reduce the ocean distance to passage over the Caribbean-Gulf region only. Allied vessels also could make pickups for British, Chinese, and Russian distribution. This would eliminate thousands of miles of precarious ocean travel by British and other Allied shipping. This routing would avoid voyaging north or south along the east and west coasts of South America.

Ships crossing the Gulf of Mexico from the "ports of accumulation" could be docked in the United States at Houston, Texas; New Orleans, Louisiana; Mobile, Alabama; at Tampico and Vera Cruz, Mexico (highways and standard gage railways to the United States border run from these Mexican ports; or at other United States ports adjacent to manufacturing centers or strategically close to Army and Navy establishments, railheads, or inland waterways, or river systems. From these ports rail, river, plane, or truck transportation could assume the final task of domestic distribution of goods.

Another alternate shipping route is that from the oil center and port of Talara, Peru, or from the port of Buenaventura, Colombia, northward up the Pacific Coast to the port of Acapulco, Mexico (a surfaced highway connects with the Pan-American Highway at Mexico City, leading to the United States border), or the ports of Mazatlan, Manzanillo, and Salina Cruz, which are connected with the United States by standard gage railways, or ships can sail directly to United States west coast ports. There have been very few ships sunk off the Pacific Coast of North and South America by the Japanese and the smashing attacks made by the United States Navy against the Japanese Navy in the Battles of Midway and the Solomons bodes ill for raiders in this area.

The Pan-American Highway could compensate in part when the enormous tonnage, and practically the entire convoying strength of the United States and our allies, may be mobilized for shipping troops and supplies to open new fronts. With new battlefronts rapidly developing, inter-American supply lines may have little or no protection against undersea attack. Every mile of highway built and used now may mean the saving of lives, ships, and vital cargoes of strategic materials for our war industries. Development of the Pan-American High way as the "Lifeline of the Americas" should prove of inestimable value in the international effort to maintain a continuous flow of raw materials to United States war industries, and a return flow of essential goods to the other Americas.

OUR *Point* OF VIEW

BEYOND THE HORIZON

EMINENTLY realistic and practical is the view which a group of New York business men and technologists are taking of the post-war industrial world In the days to come, they argue with irrefutable logic, those industries which have prepared for the inevitable transition from war production to peace-time activities will be the ones which will prosper; others will languish and possibly fail

The well-known path toward such preparedness for peace is research, applied now to future problems. Through research it becomes possible to plan new civilian uses for military products, to determine means for machinery and product conversion, to take out insurance, so to speak, on what lies as yet beyond the horizon. But many important industries today lack research facilities, do not have the manpower to establish planning departments, perhaps do not have personnel with the depth of vision needful for peering into the as yet unknown

It is to aid just such industries that the aforementioned business men and technologists have banded together in a post-war planning board. The members of this board, selected from a number of fields of endeavor in which they hold outstanding positions, represent a sum total of talent the equal of which could be employed, if available, only by the largest of industrial organizations

Yet the services of this planning group are now at the disposal of the smaller manufacturer, whose specific or general problems will be considered by specialists. Recommendations will then be made for changes, developments, or what ever, in the opinion of the experts, may be necessary to fit the machine, the product, or perhaps the manufacturer's organization itself to the needs of the future.

By such an approach the smaller, and many a larger, manufacturer will be relieved of his worries about the problems of tomorrow With these worries poured into a pool of experts, he can concentrate more completely, and successfully, on the business of the moment. Out of the pool, in due time, will flow the answers, unless, indeed, the problem proves to be completely unsolvable.

Such a realistic approach to post-war industrial activities is highly encouraging, showing as it does that some people are doing more than talking about the future The foresighted are planning for it —*A.P.P.*

SECRECY VERSUS PATENTS

WARNING that emasculation of our patent system is a danger even closer today than ever before, Dr. Robert E. Wilson, president of the Pan American Petroleum and Transport Company, recently told members of the American Chemical Society, and others, that there is a definite possibility that such emasculation would result in a reversion to the dark ages of secret processes.

"Our patent system is in real jeopardy," said Dr. Wilson. "This jeopardy is due to public misunderstanding which in turn is largely due to deliberate misrepresentations as to the nature of the patent monopoly and the part which patents play in encouraging invention and the prompt disclosure of discoveries and inventions to the public. The inevitable alternative of secrecy would tremendously retard the progress of both science and industry in this country.

"It is high time for scientists to join the patent bar and trade organizations which have heretofore borne the brunt of combatting the threat of our patent system which jeopardizes the whole future of industrial research. Unless our scientists help to educate the lay public as to the facts of the situation, ill-considered legislation may be adopted which would hamper all research, prevent the prompt and free exchange of information, destroy the market of the independent inventor, and discourage the continuance of American industrial research, of which we are so justly proud

"Probably the most serious effect that emasculation of our patent system would have on the future of research would be to encourage the use of secret processes. This would be highly unfortunate, since one of the principal reasons for the rapid advance of science and technology in the past 30 years has been the practical elimination of the secret process in favor of full disclosure and patenting as the preferable method of protecting one's rights and interests in his invention.

"If we take away a large part of the reward for disclosure, the tendency to revert to the dark ages of secret processes will be inescapable. The loss to our country would not be merely that due to the absence of competitive use of the process but even more in the slowing down of the exchange of basic information and new ideas.

"Inter-company research conferences and reports on new lines of development would practically cease and early publication of research work would seldom be permitted. Industrial espionage would rear its ugly head, and efforts to prevent it would force the elimination of the 'open door' policy of most of our industrial laboratories.

"Even though the attempt at secrecy might usually fail within a few years, the cumulative effect of the loss of time between successive improvements would tremendously retard our progress. Under present conditions new discoveries are frequently published long before the patent is actually issued, and the effect on the whole tempo of industrial progress is tremendous because so little time elapses between the discovery and the general availability of the information to stimulate new researches in a variety of fields not originally dreamed of by the original discoverer.

"We must also not overlook the effect of a drastic weakening of our patent system on our future ability to get information from abroad," Dr. Wilson said in summation. "Manufacturing conditions aboard are usually better adapted to protecting the secrecy of processes than in this country, and it is only the liberality of our patent system and the existence of a real market for worthwhile patents which has led most foreign patentees to make early application for a patent in this country."

None of what Dr. Wilson has to say in any way militates against revisions of our patent system to meet changing times; it cannot be too strongly emphasized, however, that the system itself is basically sound and should not be tampered with to meet crackpot or political or other selfish ends.—*O.D.M.*

Water and You

In Many Ways that Are Commonly Overlooked, Water is Involved in our Physiologic Processes

ARTHUR L. MEYER, M.D.

Formerly on the Staff of the Rockefeller Institute for Medical Research, and Associate Professor of Physiology in The Johns Hopkins University

A quizzical old gentleman once remarked that, in his opinion, the oceans were greatly overdone. I think that most of us, however, will easily appreciate the wisdom that prompted so wide a distribution of water over the face of the earth. Without water, life would be as non-existent as it is on the Moon. If, then, our planet is to continue as a habitat for living things, there must never be the slightest danger of a general and thoroughgoing drought.

It's really amazing how largely the human anatomy is composed of water. If a cadaver, weighing 170 pounds, and free from abnormal accumulations of water during its lifetime, were thoroughly descicated, it would weigh only about 50 to 60 pounds. We are, therefore, in very large part nothing more than animated masses of water. What is true of man is also true, of course, of all the representatives of the plant and animal kingdoms. The further fact that the youngest, the most actively growing forms of protoplasm, are highest in their water content indicates that water must have been very intimately concerned with the origin of life itself. And it is precisely by this token that the shrinkage of the senescent frame is prophetic of impending death.

It might seem that living matter, with its remarkable capacity for growth and reproduction, mental and spiritual achievement, would require something vastly more mysterious than water as its major ingredient. But strange to say, it is one of the characteristics of life to use only the most commonplace material in its structural organization. It shuns radium, gold, and platinum, but it does seize upon such things as carbon, oxygen, nitrogen, hydrogen, sodium, calcium, magnesium, sulfur, and iron; that is to say, elements which are among the most abundant in Nature.

Some of the reasons for the indispensable place that water occupies in the scheme of life are easy to understand. Water is an ideal solvent. I can think of no beverage adapted to human consumption, having a solvent other than water, and I am not forgetting milk. Even the most bibulous among us prefer to take their spirits in aqueous solution. And there is something about water which makes it the most acceptable of solvents to oxygen, so generously provided by the atmospheric ocean in which we live. Before satisfying their innate affinity for the iron of hemoglobin, the molecules of oxygen are jostled about in the watery plasma of the blood. They seem to like this. Otherwise they would not so willingly become disengaged from the hemoglobin, and submit to another jostling in a watery medium before their final union with certain tissue elements. The tissues, however, are calling for other things besides oxygen. They need fuel. It would be hard to imagine how a dish of salmagundi could provide sustenance to hungry cells if, after suitable preparation in the central cuisine of the body, it weren't given transportation to places where it was most needed. The reason that this is accomplished so effectively is partly because the vehicle of transportation is water.

The living furnace, unlike the household furnace, is obliged constantly to attend to the removal of its own waste products. Oxygen burns carbohydrates and fats into carbon dioxide and water as completely within the body as it would in a bomb calorimeter. Since water isn't really a waste product, it is retained so far as possible, but carbon dioxide is carried into the lungs, where it finds an easy exit by passing up the flue, so to speak. Things are very different in the case of proteins, however. Proteins are only partly burned in the body. The residue, which is known as urea, appears as one of the constituents of urine.

The digestive juices which are daily poured into the alimentary tract contain about four quarts of water. In a less economical system all of this water would be cast off with the indigestible remnants of food. But our bodies think highly of this water, and return most of it to the circulation. Since the volume returned is about four times the amount that the average person drinks each day, our intake of water would have to be considerably greater than it is, were it not for this provision of Nature.

Though every effort is made to conserve the body's water supply, certain loses are unavoidable. The water in the solid excreta serves as a lubricant. The urinary output carries with it the refuse of general metabolism. The water which is constantly evaporating from the lungs and skin surface is known as insensible perspiration, and, because of its cooling power, is one of the factors regulating body temperature, thus reminding one of the hot desert custom of cooling water by placing it in earthenware jars. On occasion the body dilates its peripheral blood vessels and brings into action innumerable miniature geysers, called sweat glands. But for this, and a sufficiently dry atmosphere, a thermometer rising to uncomfortable heights would be rather enervating during a stiff bout of tennis.

Beverages are by no means the only source of our water supply. Every portion of fruit or vegetable or meat contains water, and every bit of carbohydrate, fat, and protein that we burn within our bodies is actually converted partly into water. Furthermore, the body has a commendable habit of storing water against a temporary shortage. Whenever the reserves in the skin and muscles run low, we are promptly informed by a signal which we recognize as thirst. In the simple act of satisfying our thirst, we are adequately safeguarding our water balance. This thought should be a comfort to those who are given to fretting overmuch about their water intake.

When we drink "plain water," we are not drinking water in a state of unmixed purity, to be sure. There is no such thing in Nature. What we drink is always a mixture of the molecules of ordinary and "heavy" water plus something else—a solution, in other words; for even rain-water, product of a gigantic distillery, contains a dash of ammonium salts and certain gases to give it a tang, presumably lest plants should otherwise find it too insipid. On issuing from our springs, having percolated all manner of soil, it has become "hard," or chalybeate, or sulfurous, or radioactive, or what not. One sometimes marvels that its further exposure to such things as chlorine, copper sulfate, alum, and calcium hydrate, during the rites of chemical purification by our sanitary ex-

perts, should still leave it potable, not to say wholesome, when it comes from our hydrants.

But long experience has made life a connoisseur of solutions. The blood plasma, tissue fluids, lymph, and cell-sap are all watery solutions of sugar, salts, and albuminous materials Though an exchange is constantly going on between them through partitions of delicate fabric, they are always kept in a state of "osmotic" balance What passes from one to the other depends on the kind of specialization achieved by the partition itself. Some of these living membranes are permeable to water only. Most of them permit the diffusion of water and crystalloids, and many of these also allow proteins to pass, while others have denied a free thoroughfare to the protein molecule.

We'll assume that on a hot summer's day your sweat glands pour out four pounds of water in an orgy of libation to the goddess of badminton You make good the loss by drinking water, and your kidneys, always on sentinel duty, prepare a urine containing sufficiently less salt to compensate for what is lost in the sweat; for the body, you see, conserves salt as well as water Should you, by any chance, over-indulge in water, the kidneys would simply get rid of the excess, except for a portion which might be held for storage.

When the body cells live together in peace and comfort, the disposition they make of their water supply is very different from what we see in times of stress, or under conditions which alter the vital fabric.

Abdominal cramps and an intense feeling of fatigue and depression may sometimes be met in stokers, miners, steel workers, and others engaged in extremely hard work in extremely hot places. The overtaxed muscles and sweat glands of these men are so greedy in their demands on the circulation that the kidneys for the time being are out of action. In these circumstances, a heavy drain on the salt reserve, uncompensated by a corresponding intake, and a gulping thirst, over weeks and months, can do little else than produce a state of chloride shortage.

In the under-world the Danaides, you may recall, were assigned the task of forever lifting water in sieves. The story comes to mind as I think of diabetes insipidus. In this disease the kidneys have become profligate, for some strange reason, of the body's water, and permit as much as 40 pints to pass, as through an ordinary filter, in a single day. As the sieves of the daughters of Danaus probably retained things other than water, so the kidneys in this disease retain sugar and proteins. Except for its watery color and enormous volume, the urine is fairly normal Persons with diabetes insipidus are therefore not diabetics in the ordinary sense of the term

An extraordinary loss of water is again prominent in the foreground of cholera; this time from the bowel Water passes into the bowel from the blood stream against the usual traffic signals, as if in a desperate effort to flush out the invading germs Water entering the body in abatement of a burning thirst fails to negotiate the barriers temporarily set up between bowel and circulation. Hence the blood becomes viscous, and more viscous, until at last we have a condition resembling a plumbing system filled with molasses. And yet, mirabile dictu, in some instances, the diarrhea vanishes, the body warmth returns, the kidneys again function, and the patient recovers.

Though water is one of the simplest of substances, the mechanism of its physiological behavior is not so simple At this point, therefore, rather than yield to the temptation of discussing the physical forces of solution, ionization, diffusion, and osmosis, let me conclude with a word of assurance To those who harbor a fear of nausea, dizziness, and motor incoördination from too liberal an intake of water, it may be said that, while "water intoxication" is an entity experimentally demonstrable in some animals, the possibility of its occurence in human beings is quite remote. Too little water is far more likely to be disturbing than too much water. And finally, if there are those who suspect water of being a causative agent of their obesity, let me remind them that by no alchemy has water ever been transformed into fat. It may add to one's weight, but not to one's embonpoint

• • •

ULTRA-SONIC

Focused Ultra-Sound Waves From Curved Crystals

Ultra-sonic waves, which are intense sounds of such short wavelength that they are far beyond human hearing, have been produced in a focused beam in the laboratories of the College of Physicians and Surgeons, Columbia University. Turned on liver and other animal tissues, they have a destructive, "cooking" effect in the spots where they were focused. They also throw water upward in a mound-like jet, melt holes in paraffin blocks, and have other striking physical effects.

The new work with ultra-sonics is being done by a three-man research team, John G. Lynn, Dr. Raymund L. Zwemer, and Arthur J. Chick.

Ultra-sonic waves are produced by specially cut pieces of rock crystal—piezo-electric crystals—which vibrate tens or hundreds of thousands of times a second when stimulated by high-frequency electric currents. (Human auditory range stops at about 20,000 cycles a second.)

Biological effects of ultra-sonics were first studied about 15 years ago by Prof. R. W. Wood of the Johns Hopkins University, Prof. E. Newton Harvey of Princeton University, and Dr. Alfred L. Loomis of Tuxedo Park, New York, in the latter's private laboratory. At that time, the crystals used were flat, so that the "beams" of ultra-sonic waves went out in straight or somewhat spreading lines. In the new experiments at Columbia, curved crystals are used, which have the effect of focusing the waves at a point, like the concentrated light beams passing through a lens. Their effects are thus at once localized and intensified.

• • •

INSECT SIGHT—Experiments indicate that honey bees and fruit flies can see ultra-violet light, which is invisible to human eyes, reports the Better Vision Institute.

• • •

PISTON STUDY

Facilitated by New Photographic Development

Automotive engineers have put photography on the job of ascertaining how well lubricating oils meet the severe requirements of actual service The camera is built into what they call a "piston-photographing machine," which produces an image of the entire piston surface upon a single plane with practically no distortion. In use, a test piston is slowly rolled and revolved at constant speed along an arc. It presents each point of its circumference equidistant from the center of the arc for photographic exposure through a ¼-inch slot, which moves with the piston and is in line with the point of contact and with the camera lens. The resulting picture clearly reveals all marks, such as those of the original finish, scuffs, scratches, carbon deposits, varnish, and so on.

A Dream Almost Attained

A New Success Seems to Bring Astrophysics Still Nearer to the Rounded Solution of a Major Problem

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

THE EARLIER history of astronomy fell into two stages: first, that of observation in which the orbits of the planets and their laws of motion were determined, and their distances and dimensions approximately found; and second, that of theory and observation combined, when these empirical laws were shown to be consequences of the principles of dynamics and gravitation. It then became possible to determine quantities—such as the masses of the Sun and the planets—which had previously been outside even the range of speculation, and to predict all the possible kinds of orbit which a body moving near the Sun could have, and to explain the motions of comets, and by other applications to account for such things as the tides.

A similar advance in the newer science of astrophysics has taken place in our times. Forty-two years ago (when the writer began his contributions to this journal), though much fewer observations were available than now, it was possible to find the distances, luminosities, masses, diameters, and so on, of enough stars to give us a fair idea of their properties. The spectroscope gave us extensive knowledge of the composition of their atmospheres, and revealed the existence of a long series of inter-grading types. We knew a great deal; but we had little or no idea of what a star ought to be like, on general principles, or of the real significance of such things as the spectral sequence.

The great awakening came this time with the discovery and development of the principles of atomic physics, which have done as much for astrophysics as those of gravitation did long ago for astronomy.

Knowledge which once seemed beyond even the dream of attainment is now in our grasp and we are far toward a solution of the deductive problem: Given a large quantity of matter, of known composition, isolated in space: Into what configurations can it settle down for a long-enduring career? Will it be self-luminous? If so, how big, bright, and hot will it be? And what will be the spectrum of its light?

We need only recall in a few words how Eddington showed that any large mass—more than a tenth of the Sun's—would be so hot inside that it would be hot outside and self-luminous, and that the brightness would increase rapidly with increasing mass and slowly with diminishing diameter. This explained why a star of the Sun's mass should be of about the Sun's brightness, but not why it should be of the Sun's size. Later, Bethe found a set of reactions between atomic nuclei which accounted for the gradual and self-regulating production of enough heat to keep the stars shining for billions of years; and this indicated that a star of the Sun's mass and brightness should be also of about the Sun's size and therefore of the Sun's surface temperature and color. To fit the Sun exactly, the mass would have to be composed mainly of hydrogen and helium, with a small percentage of heavy elements.

WE HAVE, therefore, a reasonable explanation, on general principles, why stars like the Sun are what they are—and likewise brighter and hotter stars like Sirius and Procyon, and cooler, fainter ones like 61 Cygni. What happens inside the great red giants like Arcturus and Antares we do not know yet.

Passing from the general properties of the stars to their spectra, reasoning along the lines initiated by the Indian physicist, Saha, shows that in the atmosphere of a star of the Sun's temperature some elements, like helium and neon, would not have their atoms stirred up enough to fit them to absorb lines in the observable part of the spectrum, while others, like potassium, are so easily affected that few atoms remain in condition to produce observable lines. This explained not merely why the solar spectrum looks as it does, but why some lines get stronger and others weaker in the spectra of the hotter stars, while other changes happen for the cooler ones. The whole sequence of spectra was thus explained at one sweep, and refinements such as the differences in finer detail between the spectra of giant and dwarf stars of the same temperature soon yielded to the analysis.

At the same time another riddle was solved—why the surface of the Sun which is far too hot to contain any solid particles or liquid drops, looked like a sheet of incandescent cloud, with markings on it such as sunspots. The medium is purely gaseous; but it is full of free electrons, and the interaction between these, the light-waves, and the charged atoms from which the electrons have been lost, make the gas hazy, so that we can not see very deep into it and it looks substantially like patches of ground-fog seen from a height.

ONLY the atoms or molecules in the atmsophere above this fog can absorb the spectral lines that we observe. To be more precise, the fog thickens gradually downward, and we must count the atoms which lie above a certain average level where it is already pretty thick

On these principles it has been possible to make a surprisingly good quantitative analysis of the atmospheres of the Sun and of many stars. They are found to be composed mainly of hydrogen and helium with only a whiff of atoms of other kinds; but the relative abundance of these heavier atoms is remarkably similar from star to star, and remarkably similar in general to that in the surface crust of the Earth.

With all this long list of successes, the theory failed in one point until recently. It indicated that the lines in stellar spectra, and in the solar spectrum in particular, should be much wider and darker than they are actually observed to be. The Sun's atmosphere, down to the impenetrable haze, is surprisingly shallow. The first to realize this fact, long before its full implications could be realized, was that great pioneer in astrophysics, Sir Norman Lockyer. Sixty years ago, he exhibited to a scientific audience in London the sodium lines in the Sun's spectrum, and the same lines as absorbed from white light by passing through a salted Bunsen flame an inch thick. The latter were the stronger—and so, said he, we know that there is less sodium per

square inch in the Sun's atmosphere than in this flame.

It was more than 40 years before this half-forgotten remark was fully appreciated. Now we know that Lockyer was entirely right; but why the solar lines of sodium, and other elements, should be so faint began to be explained only three years ago.

Qualitatively, we understood perfectly well that, when an electron passes close to a charged atom and changes its "orbit," or when one is captured by an atom and later knocked off, light is emitted or absorbed in such a way that the gas, as a whole, scatters light of all colors, and behaves like a thin fog. But when the theory was developed far enough to permit of fairly accurate calculation of this scattering, it was found to be much too small. We should see deep enough down into the photospheric fog to leave at least ten times as many atoms working above it as are required to produce the observed spectral lines. Evidently there was some additional, and powerful, source of haziness in the atmosphere.

A SIMILAR situation was found in the cooler stars in general. In the A-stars, like Sirius, where the very numerous hydrogen atoms are split up, the calculated scattering agreed tolerably with observation

In 1939, Wildt, who knows more modern chemistry than most other astrophysicists, saw where the answer was. The Sun's atmosphere contains an overwhelming proportion of hydrogen. The molecules are all dissociated into atoms, but hardly any of these are ionized—it is too hard to get an electron off one at that temperature. It had been supposed that these hydrogen atoms were practically inert as regards visible light, but Wildt found in the chemical literature evidence that the *neutral* hydrogen atom has a certain tendency to attract a free electron, and build up a negatively charged atom. It had long been known that electro-negative atoms, such as chlorine and oxygen, had this "electron affinity;" but the fact that hydrogen possessed it was less familiar. This affinity is small for hydrogen (0.7 volts on the usual scale), but is sufficient to cause a certain fraction of the hydrogen atoms in the Sun's atmosphere to capture electrons. This proportion is very small, only one in 10,000,000, according to Wildt's calculations; but these atoms are continually losing their loosely bound electrons, while others pick electrons up, maintaining the average, and this process produces a very considerable scattering of light Only rough calculations of this could be made three years ago. They showed that the total scattering effect produced by this process should greatly exceed that resulting from the interaction of electrons and charged metallic atoms—which has much less influence per encounter

To proceed further was heavy work It is not possible to get enough atomic hydrogen in the laboratory to observe this scattering. It must be calculated, by the laborious processes of wave-mechanics. This was done by Massey and Bates in London, just before the war, and it then appeared that the slight scattering due to the new process far exceeded that arising from all those previously known, and accounted for the main part, at least, of the unexplained haziness of the Sun's atmosphere. Strömgren, extending it to the stars, found it equally valuable there

ONE DETAIL, however, remained to be cleared up. The calculated scattering was strongest in the violet at 4000A, and fell off considerably toward the red. In a star like the Sun, where most of the haziness comes from it, red light, having to pass through less haze, should come, on the average, from deeper and hotter layers than violet light. In consequence, the continuous background of the spectrum should be stronger in the red than it would be if the haziness were the same for all colors. That is, the Sun's light, on the average, would be redder.

The color-temperature, measured by the proportion of red to violet light, would then come out lower than the effective temperature, calculated from the total amount of radiation per unit area. This is not the case: the Sun's light is actually strong in the blue, and its color temperature is higher than the effective temperature This could be met by theory either by diminishing the calculated haziness in the blue or increasing it in the red. Very recently a new calculation has been made by Williamson, at the Yerkes Observatory, using a much more accurate, and of course more complicated, set of formulas—such that the equation expressing the *results* of a long set of calculations itself occupies half a page of print. This new and precise calculation gives just about the same absorption (haziness) as the old for the ultra-violet, but a good deal more in the visible spectrum, with a maximum in the green at 5000. This is just what is required to clear up the discrepancy. Further laborious calculations are required before it can be applied to the stars; but the outstanding discordance will surely be much smaller, and may be entirely removed, in which case we shall be at last in a position to predict what the Sun should be like from pure theory—given its composition and mass, but having never seen it

WHILE we speak of the solar spectrum, we may note a recent advance in its observation. In the remote infra-red the spectrum can be detected only by the energy which the waves carry, and very delicate heat-measuring devices are necessary. The rays must be focused by mirrors, and dispersed into a spectrum by a suitable prism Up to wave-lengths of about 13 microns, or 20 times the wave-length of red light, rock-salt is transparent and forms excellent prism material since large transparent pieces can be found in nature Beyond this, it grows opaque, and compounds containing heavier atoms must be used Potassium bromide serves very well· but the crystal from which the prism is to be cut must be grown artificially—and to get a large, flawless transparent crystal demands great skill Worse than this, the earth's atmosphere absorbs certain of these long waves very heavily. An enormous absorption band due to carbon dioxide and beginning near 14 microns has, up till now, blocked all efforts to get beyond it; but, with very sensitive apparatus, and a potassium bromide prism, Adel, at the Lowell Observatory, has passed the barrier. The automatic records of his spectrometer show strong evidence of radiation beginning at 16 microns, beyond the great absorption band, and extending almost to 24 microns. This new limit is 50 times the wave-length of blue light.

The records show numerous absorption bands—cutting off part, though not all, of the solar energy—which, from their great width, evidently arise in the earth's atmosphere. It is probable that many of these arise from water vapor, for their intensity varies with the humidity. If their effect can be eliminated sufficiently to find how strong the Sun's radiation would be without them, it may be possible some day to test theories of the intensity of the Sun's continuous spectrum over more than 20 times as great a range as is available at present.

Adel has shown that certain faint bands are absorbed by nitrous oxide, N_2O, and another by nitrogen pentoxide, N_2O_5. These must be produced at the top of the atmosphere by the action of ultra-violet light. If they occurred at low altitudes, their psychological effects would be conspicuous.—*Princeton University Observatory, Dec. 22, 1942.*

Pseudo-Fossil Man

Not All Human Skulls that Look Primitive Are Those of Ancient Primitive Man, and Why

LOREN C. EISELEY
Associate Professor of Anthropology, University of Kansas

SOME years ago, when the writer was engaged in archeological work near a small western town, a villager drew him aside and said: "You should see Mrs. Jones. She is the widow of a doctor who used to collect fossils all over this country. She has some very wonderful things, and probably would be glad to dispose of them now."

Seeking out the woman, I was led into a parlor ornamented, in the fashion of the '90's, with the usual array of sea-shells, baskets, and other odd items. Following a proper interval of small talk we came around to the subject of the interview—her husband's collection. After I had examined and made notes upon some items of local interest, a pause fell. Looking carefully about, and lowering her voice, the woman said: "This is not all. I have something very, very valuable. I have part of the skull of a primitive man."

Now, though extinct types of man have never been recovered in the New World, and the likelihood is that they never will be, it is not the business of science to make snap judgments Mentally expecting no more than some odd and misinterpreted fossil, I waited while the doctor's widow eagerly uncovered her prize.

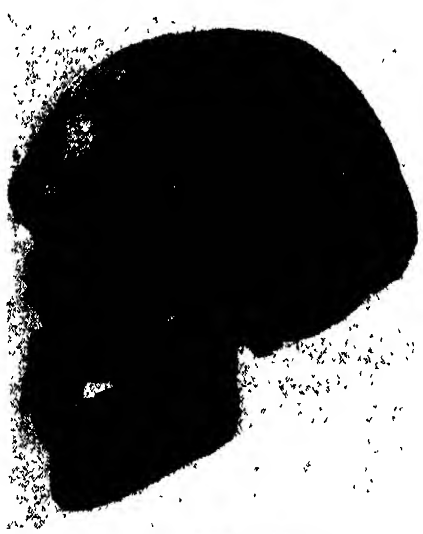
As the last wrapping fell away, there was dropped into my hand what I had least expected: a human frontal or forehead bone which, without doubt, carried an extremely massive supra-orbital torus, or ridge of bone above the eyes, such as is commonly found upon the skulls of the fossil men of the Ice Age. The rest of the skull was missing. Only this massive fragment of the skull remained.

"Where," said I, my pulse rising a point or two, "did your husband get this?"

"Oh," said the woman eagerly, "he found it buried with that other skull you've been looking at, in the Indian village up the road."

At this remark my heart quickly subsided to normal, if not below. No fossil man was going to get himself buried in a mere 500-year old Indian village. I had been digging there myself, and I knew. Moreover, fossil men are not laid out in Indian cemeteries along with the bones of the existing species of man. I tried, gently, to explain this to the widow.

"But," she exclaimed triumphantly, "look at that forehead. It's not modern



Photos by Dr. G. Ekholm, courtesy American Museum of Natural History

This skull suggests incipient acromegaly. Notice particularly the helmet-like protrusion of the brow beyond the root of the nose, and the massive character of the zygomatic arch (the slender, constricted part of the cheek bone just forward of the ear)

My husband said it wasn't. He was a doctor, and he knew. That piece of bone is worth a lot of money."

The talk shifted. We exchanged some pleasantries and I left, albeit wishing I might have carried away with me that intriguing fragment of frontal bone. I knew by then what it represented, but it still appealed to me.

At rare intervals these fragments persist in turning up. To some laymen they are extremely attractive and, forgetting that a fossil type of man is a much more complicated structure than an individual possessing a supra-orbital torus, or brow ridge, of unusual size, the finder generally visualizes in them the primitive European "cave men" about whom he has read. So scarce are these objects and so infrequent is their complete preservation that it is very easy to be deceived by them, particularly at a time when the discovery of the late glacial Folsom culture in the United States has made us extremely conscious of the possible antiquity of man in the New World. If his find is not primitive—the layman is likely to insist vociferously—what in heaven's name *can* it be?

Such specimens of pseudo-fossil men can be classified into two general types: first, the "normal" individual who represents, in one or another feature, a more primitive appearance than the average for his group; and, second, the individual who, through a glandular disorder, has suffered a marked thickening of the bony structure.

IN CONNECTION with the first, or "normal," type, we may say that in no human population are the individuals exactly alike. Each person varies in his features from what we may term the ultra-human or vanguard types, to those who, in one or another characteristics, have retained some indication of the more primeval features of the earlier men. As Dr. Franz Weidenreich, distinguished authority on fossil man, has pointed out, "within each group . . . we may be confronted with specimens seemingly anticipating future development, while primitive features are retained in others." These by no means necessarily imply intellectual inferiority, but may include an odd array of little skeletal variations of which only the anatomist has knowledge. Occasionally, however, out of so many thousands of individuals, one may show unusually pronounced brow ridges or some other feature noticeably striking to the untrained eye.

The writer can testify that he long coveted the skull of an unsuspecting colleague who approached close to the Neanderthal type in one or two characteristics of the skull. I say one or two advisedly. Viewed in its entirety, my good friend's cranium would have deceived no competent anatomist into imagining him to be one of our early forerunners. If, however, the right fragment of his skull—the "primitive" part—had been recovered from an archeological deposit of some antiquity, discussion might have arisen. Such instances are not unknown here in America, and more than one well-intentioned student has gone off the deep end in favor of some very ancient form of man having existed in the New World, only to suffer humiliation later.

The second type of pseudo-fossil man

—the glandular disorder type—represents an anatomical condition which may also contrive to trick the unwary archeologist. In this case we are dealing with a glandular disorder of the pituitary, a small gland at the base of the brain whose secretions control the course of human growth. This disease, known as acromegaly, overstimulates bone growth and, over a period of years, causes a great coarsening and thickening of the bones of the skull, particularly in the region of the brow ridges, cheek bones, and other portions of the facial structure The result is to lend the face a somewhat bestial and primitive appearance which is even more pronounced in the skull

There are degrees of intensity of affliction with this disease, and variation in its anatomical effects. In general, however, it has long been recognized that the skull, under this unusual stimulation, tends in a certain degree to simulate, in portions of its structure, anatomical traits of the primitive past of mankind. Indeed, so distinguished an anatomist as Sir Arthur Keith has suggested that man still carries within his body, and ordinarily regulated by a well-controlled pituitary, the biological mechanism which produced the physical structure of his early forerunners

BE THAT as it may, however, this rare disease, scarcely ever identified archeologically, is well worth considering as a possible explanation for unusual skulls from recent deposits Moreover, in its milder stages, it may be difficult to distinguish skeletally from a case of extreme normal variation.

The skull featured in the first photograph was collected from an early site in the Southwest, along with many other perfectly normal individuals. There is nothing mysterious about it. It is something over a thousand years old, and its associates were all perfectly normal Indians of that place and time. Yet this skull in many of its features is a remarkably rugged and "stone age" specimen of man to be encountered among American Indians, most of whom, incidentally, are by no means effeminate in skeletal structure.

Unfortunately, the bones of the body of this specimen are gone, so that we do not have them as an added check on the pathological nature of the skull. The latter has been slightly crushed. Because of the fragile nature of the bone, complete restoration has not been attempted. Nevertheless the general effect is plain; great size, ruggedness, and measurements which are very large. This skull was found in an area now being combed for traces of late glacial man, and I shudder to think what extensive essays might have been written upon that porching frontal bone if it had ever washed out of some convenient river bed or gravel deposit.

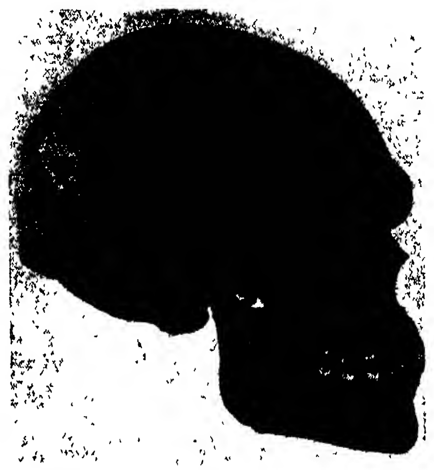
The skull is still not in what might be termed an advanced state of the disease. Nevertheless an excessive heaping up of porous vascular bone on the edges of the tooth-bearing portion of the upper jaw, and a chalky and spongy bony texture, are very suggestive of acromegaly. The brows contain huge air sinuses and the condition of the sutures of the skull suggests unusually early closure. Notable, too, is the bicanine index of this specimen

This index, expressed as a percentage, indicates the width between the two canine, or "eye teeth," as compared to the width as measured across the maximum expanse between the molars.

A high index is a sign of primitiveness because the primitive or anthropoid jaw is more U-shaped or rectangular, and hence the canine teeth are almost as far apart as the molars. On the other hand, due to the more retracted and curving palate of modern man the index is much less in the latter. In the anthropoid apes, the index ranges in the high nineties, or even to 100 or over. In modern Europeans, it ranges in the low sixties. In the powerful and anthropoidal Rhodesian man, the index is 68 percent. Our specimen has an index of 68.5, indicating a wide primitive muzzle. As a matter of fact, the bicanine width is 48 mm, which is much beyond the average. It is interesting in this connection to note that in acromegaly there is sometimes a tendency for the "eye" teeth to advance slightly in position and be more directly in line with the incisors, thus creating a wider, more primitive arch.

If, however, one has access to the whole skull, as in this unusual specimen, there should be nothing deceptive to the trained eye. It is not really primitive. The brain case is capacious, and the face, though formidable in its ruggedness, is that of our own species.

It is important to remember that none of our human forerunners is ever completely imitated by either pathological or normal variation. In the case of disease, the bone betrays evidence, not of primitive strength, but of ab-



Left and above: **Front and side view of the skull of a native of New Britain (northwest of the Solomon Islands). This individual is markedly variant toward the primitive, but not in a pathological manner. Note heavy development of the brow ridge, which is striking, even when it is seen in this somewhat archaic group of people**

normality. Moreover, the spurious primitiveness will tend to be localized and asymmetrical. One never gets, for example, the lack of the chin eminence so characteristic of the subhuman remains. On the contrary, in acromegaly the chin eminence may be pronounced In the case of extreme normal variation of an atavistic nature the duplication is also not complete, but generally confined to a single character.

Such specimens as we have discussed remain as an emphatic scientific warning against easy and popular supposition. This is not to say, when you remove a curious and exciting skeletal fragment from its ancient resting place, that it should be casually dismissed. But before letters are written to authorities or dramatic announcements made to the newspapers, make sure that your prized, and in any case interesting, specimen is not that of a forgotten acromegalic, or an extreme case of normal variation toward the primitive. The search for fossil man is more, far more, than a search for skulls with big brow ridges.

A wash-drawing, reproduced from Scientific American for January 1898, showing the *Argonaut* on ocean bottom. Note diver, searchlights, masts

Simon Lake, Submarine Genius

The Early Struggles of the Man Who Laid the Foundation for the Science of Underwater Travel

HARLAND MANCHESTER

About 45 years ago a wild-eyed fisherman staggered into a Virginia country store shouting that the Devil was after him. he had been peacefully fishing on the Rappahannock River when he saw what appeared to be a buoy, floating upstream against the laws of Nature Then with a clap of thunder and a smell of brimstone, a bearded, red-capped Lucifer rose up from the waves.

The quaking man went home and the hamlet's theological experts gathered around the cracker barrel to debate the revelation. Then the door opened and in came Simon Lake, intent on stocking the larder of his newest submarine, the *Argonaut I*. Hearing the story, he returned to his boat and quickly submerged. Some of those river men are good shots.

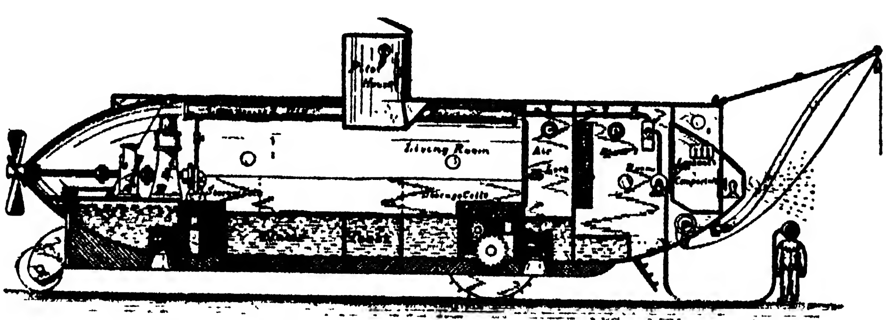
It didn't surprise Simon Lake to be mistaken for the Devil. He was accustomed to the superstitions and prejudices he has been combatting all his life. People in his home town in New Jersey smiled and made circles at their heads when he passed, and Washington naval experts bluntly told him that the ocean-bed trips he was making every day simply could not be done. They cited facts to prove it. But he went ahead doing the impossible, and, to make himself even more ridiculous, he claimed that these crackpot craft of his would be a major weapon in future wars,. that you could blockade coastlines with them and sink shipping, that one of them could knock out a battleship!

As a red-headed, 14-year-old boy of Pleasantville, New Jersey, with little schooling and a hearty dislike for classroom discipline, Simon Lake read Jules Verne's *Twenty Thousand Leagues Under the Sea*. It kept him up all night and launched him upon his career. He immediately began planning a boat that would realize Verne's dream, and ever since that day in 1880 he has been constantly designing submarines and devices to improve them

All the Lakes were inventors. Grandfather Lake invented a seed-planting machine, Father Lake a window-shade roller, Cousin Vincent a typewriter, Cousin Isaac Risley a printing device, and Ira a telephone Uncle Ezra, a minister, built a flying machine and tried, without success, to fly it from one gallery of his church to the other None of these New Jersey Lakes was dismayed by the unknown, or cared a rap if the neighbors thought him crazy They were as ready to build an airplane or a submarine as they were to fix a door-latch, and if Simon had planned a rocket ship to fly to the moon, they would have listened with respect.

When the town fathers voted to build a road across the marshes to Atlantic City, then virgin terrain, the horses got mired to their bellies, and it seemed impossible to continue. But Uncle Jesse Lake took an old-fashioned horse treadmill, turned it upside down, mounted an engine on it, and thus created an endless-tread tractor to do the job. He later refused a large sum for his patent. Money never meant much to the Lakes Jesse also invented a mowing machine which he sold to McCormick, a whistling buoy, and practical joke gadgets Taking a fancy to Simon, Uncle Jesse brought him into his foundry and taught him to use tools. That shop was Simon Lake's university.

Bushnell, Fulton, Holland, and others had built under-water boats of sorts, but they were unreliable affairs that killed many of their crews, and Lake



A sectional view of the *Argonaut*, also from Scientific American, showing engines, cabin, storage batteries, wheel-operating mechanism, and the air lock for divers

was convinced that they were wrong in principle. Most of them dove head first. This often piled the crew up in the prow of the boat, it made navigation a matter of chance; sometimes the boat stuck its nose in the bottom and remained there permanently. Lake planned an "even-keel submersible," one which, by means of projecting vanes fore and aft, would retain its horizontal position while submerging and while submerged. This principle is now used on all submarines

THAT was only one of the problems which this boy in his teens solved in the years of hard work before he actually built his first submersible boat Science in those days could throw little light on the things Lake needed to know For instance, how much air does a man need to live on? Lake asked university professors, but no one could give him the answer. So he built a large, air-tight, wooden box and cooped himself up, watch in hand, to find out how long he could stand it From these tests he found that he needed 15 cubic feet of air per hour, and he has used that figure ever since

He heard that at Johns Hopkins Hospital bad air was exhausted from the contagious ward through little holes in the floor. This must mean that bad air is heavier than good air, he decided, and again shut himself up in his box to prove it. He lit matches, raised and lowered them, and as the minutes ticked by, noted the heights at which the flame was smothered by the rising level of exhaled carbon dioxide. As a result, his plans provided for the forced exhaustion of bad air through the floor of his submarine compartments.

In Jules Verne's fictional *Nautilus* there was a compartment through which divers could emerge to investigate the ocean bed. Lake decided that he needed an under-water exit in his submarine It was a little matter of opening a door on the sea and at the same time keeping the water out. Lake was thinking it over one evening when his eyes fell on an old powder horn left by a pioneer ancestor. The horn had a small measuring compartment near the tip. When this space was full of powder, an inner valve closed, and the outer one could be opened to pour the correct charge into the musket barrel. Lake saw the answer to his problem in a flash, and hastily blocked out plans for his submarine "air lock." It was a small, air-tight room with two doors, one opening into the interior of the boat; the other, a trap door, opening to the sea. He could enter the room, release compressed air until the pressure was high enough to keep the water out, then open the sea door. Crews could collect oysters and crabs through the open door, or don diving suits to salvage wrecks or look for mineral deposits. To Lake, this sea-bed exit was one of the most important features of a submarine, for he planned the boat for peacetime commercial use, not as an engine of destruction

For 12 years Simon Lake put in his evenings and odd moments planning his submarine. Meanwhile he earned an ample living working in the family foundry, and from inventions that were more immediately remunerative. For example, his safety device for windlasses on oyster boats, which prevented the crank handle from spinning backward and killing the operator, sold well In 1892 the Navy, aroused at last to the value of the submarine, advertised for bids. Here, Lake thought, was a chance that the *Argonaut*, the name which he had given to his "paper" submersible, would be built.

In high spirits he took his plans to Washington. But he had never heard of scheming lobbyists and indifference in high office. They let him cool his heels for two days, then curtly dismissed him after a brief interview. On his second try, the Naval Board of Construction approved his plans, but in those days the final decision concerning types of vessels to be built lay with Congress. Lake's rivals had money, influence, and political acumen. Lake lost out, and $200,000 was spent in building a Holland "diving-type" submarine which never performed satisfactorily.

Determined to build his submarine and prove his case, Lake went to Wall Street in search of a backer. But a crank had just tried to kill Russell Sage, and when the shock-headed stranger talked about a boat that would roll on the bottom of the sea like a tricycle, the men of money turned pale and called their secretaries. Lake went home empty-handed.

No one understood his ideas but the other Lakes, and it was a member of the family who came to his rescue in the fall of '94. His Aunt Annie Champion, who had some money put away, asked him how much it would cost to build a kind of small "sample" submarine, and his cousin, Bart Champion, said he would help him build it.

Lake accepted Aunt Annie's offer, and he and his cousin spent a happy winter building a tiny submarine out of "spit and string." He has turned out many powerful sea monsters since that time, but the building of the 14-foot *Argonaut, Jr.* was the greatest adventure of his life. She was a stubby, box-like craft covered with two layers of pitch-pine, with canvas between, but, because of the limitations imposed, she lacked many of the refinements of Lake's planned submersible. She had tanks which could be flooded with water to offset her buoyancy so that she would sink. There were three wooden wheels on the bottom; a front one for steering, and two rear ones driven by a crank inside which was turned by manpower. Lake's cherished idea, the air-lock, with its trap door opening to the sea, was built into her stern. There was an old soda fountain tank for compressed air to hold back the water when the sea door was open, this was filled by a second-hand plumber's pump. Air for breathing came through a pipe from a buoy on the surface, and as a final touch, there was a small gasoline stove for cooking fish speared through the trap door

The *Protector,* Scientific American, December 1903. She passed gruelling tests for the United States, but was rejected. Russia bought her for use in harbor defense

THE launching of the *Argonaut, Jr.*, in 1895, was an event comparable to the Wright brothers' first flight, yet the world gave no heed when the two men trundled the crude ark to the Shrewsbury River and wagered their lives on Simon Lake's calculations. Everything worked according to plan. They screwed down the hatch, flooded the tanks and sank to the bottom, then cranked the machine across the river

A later Lake invention. The *Explorer*, 1932, a commercial submarine designed for salvage operations. She was equipped with grab buckets on the end of lazy tongs

bed and back to the starting point

That summer they had more fun than Huckleberry Finn with his raft. They poked around the bed of New York Bay for sea food, and Lake went through the sea door in a home-made diving suit to explore the bottom. They gave an exhibition for the town fathers, who couldn't quite believe that they actually gathered oysters from below. So the dignitaries signed their names to a weighted shingle and threw it in the river, and the submarine pioneers went down and retrieved it

ALTHOUGH the little *Argonaut, Jr.* was a practical submarine, few people took it seriously, the press viewed it with amusement, and Washington remained officially incognizant. But a few informed people came to Lake's aid with funds to build an all-metal, gasoline powered boat, launched in 1897. This was America's first successful full-sized submarine. It went through its trial runs with flying colors, and rode out the roughest of storms. It attracted attention all over the world, and was the precursor of today's powerful submarine cruiser.

During the Spanish-American War, Lake had taken the *Argonaut* to Newport News and had easily located the harbor mines. He told a naval authority what he had done, and showed how easy it would be for a submarine like his to put mines out of action and cut telegraph cables. He was told that what he said he had done was impossible, and that if he did it again he would be thrown in jail! Lake declared that he would never go to Washington again until they called him, and turned the *Argonaut* over to commercial work in salvaging sunken cargoes.

Fully aware that his boat was by no means perfect, Lake worked out improvements with his limited funds, and drew up plans for larger and better submarines. Working at his Bridgeport plant in 1900, he quickly saw what other experimenters were discovering, that a submarine must be able to see above the surface while submerged. He went to optical firms and asked them to make some sort of tube with lenses which would serve the purpose They declared flatly that it was impossible. Lake had heard that word so many times that it had no meaning, so he bought a miscellaneous assortment of lenses, found a craftsman who could make optical equipment to his order, and began to experiment. He built a tube-like box and stuck the end out of his office window, then adjusted the lenses in various positions in an attempt to get a view of the street. It was no mere matter of bending light around a corner. Lenses of the correct focal lengths had to be fixed at precise points in the tube to relay the image to the eyepiece. His chance of success was little better than that of the fabled monkey of writing a book by hitting typewriter keys at random, but after several months and hundreds of experiments, he finally looked in the tube and saw a clear view of the street. Then he went to lunch, it started raining, and the office boy pulled in the tube and jumbled up the lenses. Despairing of ever passing another miracle, Lake went to a Johns Hopkins expert and posed his problem. The expert said it was impossible.

"But I've already done it," said Lake.

"In that case," said the professor, "give me all the data you have and I'll see what I can do "

In about a week he found the answer and Lake had his periscope.

Meanwhile, the government was awakening to the need for submarines and, in 1901, Lake was called to Washington. High officers in the Navy, scornful of the Holland vessel that Congress had paid for, urged him to build a better one. There was no appropriation, but the officers promised to do their best to secure adoption. Lake raised money from his stockholders to build the 65-foot *Protector*, designed for coast defense. Work was stopped when a rival firm sued him for libel and attached his plant, but he hacked his way out of the difficulty and finished the boat. He called on William Howard Taft, Secretary of War, and Taft promptly sent three Army officers to see the boat in action. The *Protector* passed gruelling tests. She submerged for ten hours, she navigated under the ice, and she simulated the laying of mines. The investigating board made an enthusiastic report but the bill was killed in Congressional conference.

RUSSIA and Japan, then at war, were both interested A patriotic man, Lake did not wish to sell the weapon to a foreign power, but it was the only alternative to financial ruin. He chose Russia, and the *Protector*, hoisted to the deck of a freighter and covered with tarpaulins, was quietly shipped abroad. Her inventor followed, and spent seven years building submarines for the Russian government.

Lake's stay abroad shaped history in a manner that he could not foresee. Krupp, the German arms firm, examined Lake's plans and offered him a fat contract. Then they discovered that Lake's patents were not protected in Germany, and tore up the contract Admiral von Tirpitz had talked with Lake and conceived a plan for offensive submarine warfare, and Lake's patents were legally stolen to build Germany's U-boat fleet.

By this time Lake's fame as a submarine builder was international, and he thought that his own country would finally recognize his ability. He had plans for an improved submarine, and built it at Newport News with some Navy encouragement. But the answer was still "No." England and Russia fought for the boat, and Russia won. Lake then promised the United States Navy the fastest and most powerful submarine in the world. He would built it with his own money, and if it didn't make good on all his claims, the Government could have it for nothing. The 161-foot *Seal*, launched in 1911, quickly made world records The ice was broken at last, and Lake was given

contracts for five more boats. With World War I, he came into his own. In his shipyards at Bridgeport and Long Beach, California, he built more than 40 submarines for the government which had so long rejected him.

Simon Lake has excited public imagination for almost five decades, and many people will be surprised to learn that he is still alive. He is as full of ideas as ever. A great-grandfather at 76, he is hard at work on an experimental project vital to the war. One eye is habitually closed, the result of years of squinting through periscopes, and he takes his time climbing stairs, but after a day at the plant and a half-hour for dinner, he fortifies himself with a handful of cigars—his only indulgence—and works over plans until midnight.

This obsession with machines persists in his progeny. A son, Thomas Alva Edison Lake—named for an old friend—and three grandsons carry on the Lake tradition as engineers. They have all had more technical training than the patriarch, but they have great respect for his way of cutting through a problem.

There is a common impression that the submarine has reached its peak. but Lake shakes his gray shock and declares that the boat is in its infancy. He still preaches commercial submarines, and will not consider his life work complete until he has proved their value to the world. Recently he proposed a fleet of cargo submarines of 7500-ton capacity as a means of solving the shipping shortage. He says they can be built as cheaply as tankers, will cost less to operate because of elimination of wind resistance and the buoyant effect of the water, and can easily escape raiders by submerging

In his early days, Lake used the *Argonaut* to recover coal and other cargoes from sunken vessels at a profit, and later he built equipment to recover the gold of the sunken *Lutine* in the English channel, a project which was shelved in favor of building the *Seal*. He has maritime charts on which black dots marking sunken ships turn the ocean into caviar, and predicts that much of this vast store of lost wealth will sometime be redeemed by underwater wrecking boats and that rich undersea deposits of gold, platinum, and radium will be mined by submarine Underwater oil wells have already been drilled off the California coast. Lake has a plan for recovering ocean-bed petroleum by submarine, and declares that as oil becomes scarcer, his method will be adopted.

Of course there are experts who will call these things impossible, but Simon Lake never understood that word.

• • •

TENT

With Floor For Maximum Protection

A SPECIAL pup tent equipped with a built-in floor has been developed for mountain troops. It will offer protection against mosquitoes and other insects and furnishes ample protection against rain, blizzards, and wind velocities up to 75 miles an hour. Whereas the regulation pup weight 14 to 15 pounds and is made of canvas, the newcomer, complete with poles and pins weighs only seven pounds and is made of a featherweight nylon cloth. Two men can sleep with ample room, and in an emergency, three soldiers can be bedded down for the night.—*The Army Officer*.

TELEPHONE ALARM

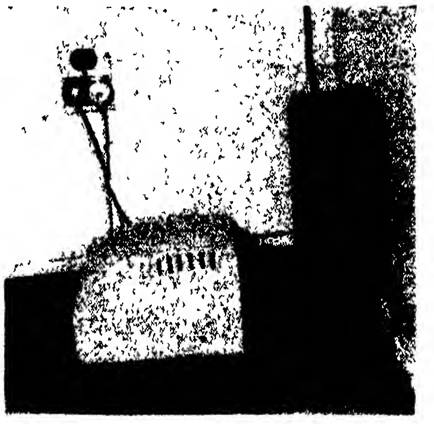
Used to Summon Air-Raid Warden from Workshop

AN "Electric Sentry" is now on air-raid service in at least one home, that of Mr. F. Dickie, of Los Angeles, to bring warning of phone calls. which might be in connection with air-raid duties.

Mr. Dickie, as an air-raid warden, is subject to call at any time. He is also an enthusiastic home workshop fan given to spending most of his evening hours in his shop, which is to the rear and quite remote from his home His was a problem of having phone calls come to his attention in his shop when other members of the family are absent from the house.

An ever-ready sentinel for the warden

The problem was solved by installing the transmitting end of a Zenith Electric Sentry in front of the phone bell and by plugging in the receiver end in the workshop Now, when the phone rings, Mr Dickie immediately hears it and can hasten to the house to take the call Also, when he goes to visit his next door neighbors he need only take the receiver end along and he can keep an ear on his phone bell the whole evening long.



Transmitter at the bell-box

No wiring is required with the Electric Sentry, it only being necessary to plug the units into the house light sockets for satisfactory operation.

• • •

DOPE—The same chemical, cellulose acetate, which, used as a "dope," gave tautness, resiliency, and strength to wing fabric on comparatively flimsy airplanes of World War I, now is the transparent plastic which affords protection and clarity of vision to flyers in their sturdy training planes and gliders of 1943

• • •

DIESEL CRANKSHAFT

Induction Hardened, Sets Remarkable Record for Wear Resistance

AN example of the value of hardening metal by electrical induction was recently demonstrated when the vital parts of one of the world's fastest "streamliners" were inspected after the locomotive had piled up a million miles of service.

In checking the engine parts, the wear on the crankpins was found to be only .001 inch, even though the train had traveled a distance equivalent to forty times around the world. According to metallurgical experts, this unusual record was made possible because the crankshafts of the engine

A huge Diesel crankshaft set up for induction hardening

were hardened by an electrical induction process introduced by The Ohio Crankshaft Company of Cleveland

In order that the crankshaft may stand up under the tremendous pressure exerted by the locomotive's 12 cylinder, V-type, Diesel engine, the surfaces of the bearings and crankpins were selectively hardened by the Tocco process, providing accurate control of depth, width, and structure of the hardened area.

INDISSOLUBLE

Plastic Developed, Has High Abrasion Resistance

DEVELOPMENT of an entirely new transparent plastic having many times the abrasion resistance of other clear plastics was announced recently, but, because of priorities and other restrictions, this new plastic is not yet in commercial production, and is not expected to be available for any but experimental purposes for months.

The new plastic, called C. R. 39, is one of a group of resins resulting from many years of research activity by the Columbia Chemical Division of the Pittsburgh Plate Glass Company. Its properties are such that it is in numerous ways far superior to similar products now in use. It does not dissolve in acetone, benzene, toluene, alcohol, gasoline, or any of the common solvents.

Its resistance to abrasion is 10 to 30 times greater than other clear plastics. It retains its shape even when exposed to high atmospheric temperatures and can be formed into large sheets, either clear or laminated, by the application of extremely low pressures. In transparent sheets its strength, weight, clarity, and impact resistance are comparable with other transparent resins.

In its primary form C. R. 39 is a clear, low-viscosity liquid which, in the presence of a catalyst and heat. hardens into a crystal-clear solid Layers of fabric, paper, and the like can be impregnated with the liquid material and cured under low pressure to form sheets or shaped objects with a minimum of expense for tooling. Ordinary plastics used in this way require pressures of from 50 pounds per square inch to many tons to produce a suitable laminated material.

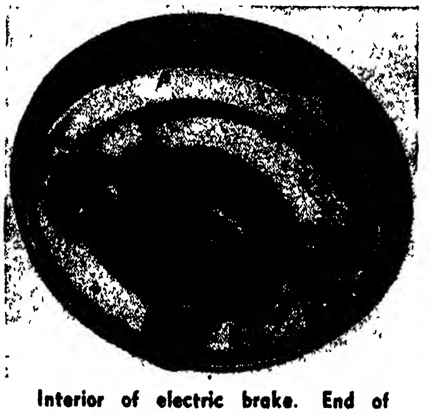
Since C. R. 39 is thermosetting and releases no gaseous or liquid by-products when curing, it opens up a broad new field of plastic applications not satisfied by any other resin. Large flat sheets and intricate three-dimensional shapes can be made with ease

ELECTRIC BRAKE

New Used on Guns, Tractors, Machines

AN ELECTRIC friction brake came into being just before the rumble of war in Europe; it was just arousing interest among technicians when the demands of war put it to an even more severe test than anything that would have been accomplished in civilian life.

Present and continuing research with this brake is showing its value in many ways. It is being used on large anti-aircraft gun carriages, on self-powered

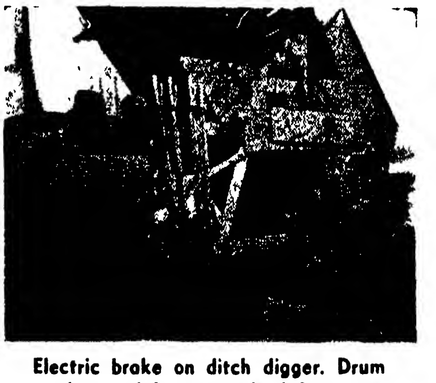


Interior of electric brake. End of magnet shows as a disk at left center

ditch diggers which run on tractor treads, and on injection plastic molding machines. On the anti-aircraft gun carriage it makes the carriage independent of its towing tractor or truck for breaking power; on the ditch digger steering is by means of breaking the treads and, with the electric brake, is accomplished with no physical effort on the part of the operator; on the injection molding machine the brake holds the plunger against 50,000 pounds of pressure where other brakes have failed.

The simplicity and effectiveness of this new electric brake, called the magdraulic brake, is due to the design of the operating magnet, a unit so carefully conceived that only a small amount of current is needed to operate the brake.

Functioning of the magdraulic brake is simple. When the magnet, shown in one of our photographs, is energized, it tends to draw itself toward an armature plate fastened rigidly to the brake drum, and the drum tends to drag the magnet with it. The resulting movement operates a cam which expands the self-energizing brake shoes. Control of



Electric brake on ditch digger. Drum at lower right, controls left center

the amount of braking is through a simple manual or foot operated rheostat.

The amount of current drawn by the electric brake is on the order of one ampere for installations such as would be used on the average passenger car; for heavy trucks and trailers up to two amperes are used

CREEP

Of Metals Measured by Electronics

AN ELECTRONIC robot, including a photoelectric cell, now measures the rate at which metals flow when heated and stressed in the General Electric Research Laboratory. Not only does this release for other important work the attention of a man who formerly watched the metal sample through a microscope; it also is more sensitive


For Flying Fortress flyers. Complete, even to sail

than any human observer and more reliable. It watches all day without ever getting tired.

These measurements of the "creep" or flow of materials are being made by Dr. Saul Dushman, assistant director of the Laboratory. Since a steam turbine, for example, operates with greater efficiency the higher the temperature, metallurgists try to create alloys for parts which will hold their shape under high stress and the greatest possible operating temperatures.

Some time ago Dr. Dushman described an accelerated method for making creep tests. The usual tests use a bar of the sample metal, which is heated in a special furnace to the range of operating temperatures, or 800 to 1400 degrees, Fahrenheit. Such tests may require months to complete. The new method uses a thin wire of the metal, and passes an electric current through, to heat it to perhaps 2000 degrees, Fahrenheit. This wire is enclosed in a glass cylinder, which protects it from air currents, and even permits the tests to be made in an atmosphere of nitrogen, thus preventing rusting from the oxygen in the open air. A weight is attached to the wire. Through a microscope focused on the lower end the observer formerly watched and measured the slow stretching, as much as one half of one percent an hour. Data are obtained much more rapidly by this method than formerly.

To make the measurements automatically, J. T. Mireles Malpica devised the robot, and the apparatus now used was constructed by Eric T. Asp, of the Research Laboratory.

The principle may be demonstrated with a flashlight and two combs. Hold one comb over the lens of the flashlight, and you can shine a spot of light on a nearby wall. Now hold the other comb over the first, close to it with the teeth parallel, and move the second comb very slowly. When the teeth of one cover the openings of the other, the light is cut off. But when the second comb moves the width of a tooth, the clear spaces are lined up and light passes through. If the flashlight and first comb were firmly fixed, and the width of the teeth and openings were known, it would easily be possible to measure the movement of the second comb merely by counting the alternations of light and dark.

This is exactly what Mr. Malpica did. A light shines through a glass grid, ruled with horizontal black lines, each 1/250 of an inch wide and the same distance apart. Attached to the bottom of the test wire is another such grid, nearly in contact with the first. A lens forms an enlarged image of these grids on the surface of the photocell. A very sensitive meter, in which electronic tubes are used, makes in ink on a moving strip of paper a record of the changes in current from the photocell, hence in the changes in brightness or the movement of the second grid. In this way it is possible to measure accurately an extension of the wire as small as 1/10,000th inch.

FORTRESS RAFT

Provides Safety Equipment For Forced-Down Flyers

An improved seven-man rubber life raft which will give aviators forced down at sea greatly added protection and comfort, including a square rigged sail, was designed by the Equipment Laboratory of the A.A.F. Materiel Center, Wright Field, working in collaboration with the United States Rubber Company, will be put into use on our Flying Fortresses.

Numerous improvements, both in construction and equipment, grew out of the experience of those who have been rescued at sea after spending weeks in inflatable boats. The new design not only gives more space, but makes the boat less tippable and more sea-worthy. A fabric sea anchor will be used to keep the nose of the boat into the wind and thus reduce the possibility of tipping caused by heavy seas.

Two ten-foot lengths of rope are tied on opposite sides of the boat to aid in "righting" the raft if it inflates wrong side up or is overturned. A horizontal bulkhead divides the boat into upper and lower chambers so that the entire boat will remain inflated though pierced by a shark or other object from the bottom. A sail is provided as well as a tarpaulin with which the crew can protect itself from the elements.

Beside the sail and wooden oars on which the sail may be rigged, equipment includes a fishing kit, emergency repair and signal kits, and first aid equipment. These items, together with concentrated rations for 30 days, and, in some boats, a radio sending set, supplied by the Army Air Corps, will be placed in a special waterproof container secured to the floor of the boat Thus they cannot be lost when launching the boat or in case it is overturned.

Dimensions are approximately 12 feet long and 5 feet 8 inches wide, and weight, complete with equipment, is only 70 pounds The boat deflated with equipment rolls into a carrying case 3 feet long by 1½ feet in diameter. Like all Army boats for rescue at sea, the top is orange-yellow for quick visibility and the bottom is blue to avoid attracting sharks.

GOGGLES

Of Various Types for Army and Navy Uses

New types of eye-protection goggles, one of which permits naval observers to look directly at blinding sun and spot dive-bombers, are now reported to be conserving and sharpening the eyesight of America's embattled soldiers, sailors, and fliers. Designed at the request of the Army and Navy, hundreds of thousands of the new war goggles are being produced by the American Optical Company, special lenses in the goggles making them suitable for different military purposes.

One of the goggles, equipped with glare-reducing lenses that absorb invisible ultra-violet (sunburn) and infra-red (heat) rays, is used by the Navy for observation purposes and to spot planes, especially dive bombers obscured by the sun's rays. Another type is fitted with special lenses which.

in addition to blotting out reflected glare, can be rotated by hand to exclude as much light as desired.

Another goggle is made with clear unbreakable plastic lenses and these are worn by sailors exposed to cold weather, wind, and flying spray. A fourth type, for ski troops, is fitted with lenses that screen out reflected glare—and also the ultra-violet rays which may cause snow blindness.

For mechanized troops, goggles with unbreakable plastic lenses have been designed, and these protect eyes against dust, wind, and glare. A sixth type for Army and Navy fliers has precision-ground absorptive glass lenses which permit accurate flying, bombing, and sighting.

Lenses of most of these goggles are inserted into soft rubber cushions that fit exactly around the eyes. These rubber masks protect eyes against dust, wind, or water.

• • •

PAINT AND WAR—The inside of a combat tank is painted white to help the crew see better, bombs and shells are finished in different colors for instant identification, and zinc yellow priming coat is used instead of red lead on aluminum alloy metal surfaces, particularly those coming in contact with salt water, such as seaplane pontoons.

• • •

CIVILIZATION'S END

Seen If Spirit Fails to Keep Pace With Science

"UNLESS man uses his reasoning power to keep pace spiritually with mechanical developments, our civilization can disappear as other civilizations have," James F. Lincoln, President of The Lincoln Electric Company, said in a recent address

"We all recognize that technological advance has had a profound effect on the life of every individual," Mr Lincoln continued. "The thing we do not recognize is that this same technological advance has taken place also in the art of war. War is not the comfortable, short, decisive thing of 130 years ago or even of our own Civil War. It is, instead, unthinkable destruction from which no generation fighting it ever recovers.

"War is still in its infancy It is a perfectly safe thing to say that if the creative genius of the research workers now in the laboratories of the United States should be directed completely to the arts of war that the tools which they could develop within the next few years would be capable of killing every person in the world in a week. It is because of the fact that this imaginative genius has been used in the arts of peace that civilization has not already been destroyed in this war. War as a means of settling disputes between nations must be outmoded or this civilization will disappear.

"The experience of all business in settling disputes has demonstrated the fundamental fallacy of fighting as a means of reaching a tenable agreement Industry always, therefore, sidesteps conflict. We must learn the same methods as nations.

"There are two courses open to us—one is to follow the brave but silly goat bucking a grindstone swinging on a rope till he kills himself—the other is to learn by mutual understanding to live at peace.

"A great philosopher two thousand years ago outlined the principle which can permanently settle all disputes between people or nations—The Sermon on the Mount. This is not the principle of the weakling; it is the principle of the strong and stalwart man. It is not only just a way out, it is the only way that nations can live with each other It is not new. We have had endless experience with it in the family, in our contact with our friends and in our

industrial activity. It is not an experiment, it is a fundamental fact. War as we know it now is outmoded because it is no longer war—it is suicide."

• • •

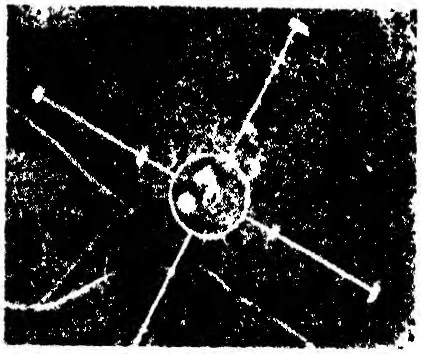
KILLER—Cockroaches can swallow phenothiazine without harm, but if this chemical touches the outside of their bodies it kills the pests. The phenothiazine passes through the shells of the roaches, and is apparently converted into another compound which really does the killing.

• • •

BOMB SCORING

Made More Accurate by Microphone Method

A NEW method of automatic and instantaneous scoring of bombing accuracy which enables officers at the world's largest bombardier college to check the accuracy of bombs dropped by cadets on targets 20 to 60 miles



As the bombardier sees new target

distant has been perfected and has been installed at the Midland AAF Bombardier School in Texas.

The new "sonic method" which was developed under the supervision of Capt. Edward Peter McKaba, Experimental Projects Officer, utilizes

Concrete housing for bomb microphone

methods originally devised for exploring new deposits of oil.

In addition to speeding up the scoring of each cadet's bombing proficiency, which now requires a large staff of officers and men, the new method will bring about a substantial

saving in such scarce commodities as rubber, gasoline, and motion picture film. It will not only be less expensive but will be more accurate than past methods.

The new "sonic method" was developed by Capt. McKaba from the seismographic method used for locating oil deposits. In this work, an explosive is set off on the surface of the ground. The sound is reflected by the sub-surface layers and picked up on the surface by a row of geophones which are like microphones. These sounds are recorded on photo-paper and can then be interpreted to plot the contours of the sub-surface layers.

The problem of bomb scoring is very similar. Four microphones are placed in a square pattern about the target center, each 500 feet from the center. By recording the time of arrival of the sound waves from the bomb explosion at each of these microphones, the bomb's position can be plotted. For instance, the sound wave from a bomb in the target center will arrive at each microphone at the same time. If the bomb is off the center, then the sound will arrive at the microphone nearest it first and at the other microphones in the order of its distances from each. These values as recorded can be applied to a unique hyperbolic plotting board devised for this purpose by Capt. McKaba, and the bomb's position determined.

Heretofore, the explosion of each of the 200 bombs dropped by every cadet during his 12 weeks of training here has been photographed by a camera from the bombing airplane. With planes aloft an average of 20 hours a day, the developing of this film has assumed proportions which rival those of the largest Hollywood studios. Adoption of the "sonic method" will eliminate the need for these expensive cameras and this great quantity of film, plus the labor and materials required to process it.

Another great advantage of this new system is that it may be wired back to the home base through leased telephone lines so that the bomb-scoring crew may score each bomb the instant that it hits.

WAR MEDICINE

New Knowledge Can Stem Epidemics

ONE of the greatest questions of the present war is whether modern science is capable of preventing the recurrence of epidemics which in all past wars cost more lives than were lost in battle, according to Dr. Bernhard J. Stern, in a paper prepared for a Cooper Union symposium on "Medicine in Wartime".

The influenza epidemic that followed World War I killed more victims in a few months than all the armies in four years, it is pointed out by Dr Stern, who is a Columbia University sociologist and author of "Society and Medical Progress." In the United States alone perhaps half a million died; the worldwide mortality is estimated at from ten to twenty-one million.

There have been prodigious advances in epidemology since the last war, and there are elements of hope in the global conflict now raging if the resources of medicine are utilized to the full, Dr Stern believes. "In World War I soldiers got vaccines to protect them from typhoid fever, paratyphoid, and smallpox," he says. "This time, in addition they get shots to ward off tetanus, which is lockjaw that results from contaminated wounds, and yellow fever. If they are going to North Africa they get added protection against typhus. If they are on the way to India they get vaccines for plague and cholera. New yellow fever vaccine promises to be of special importance.

"The results of advanced knowledge of immunology are already apparent. During the Spanish-American War one out of every twenty soldiers contracted typhoid fever. Ten percent of these died. During the first half of 1941 there were only three cases in the entire army, and no deaths."

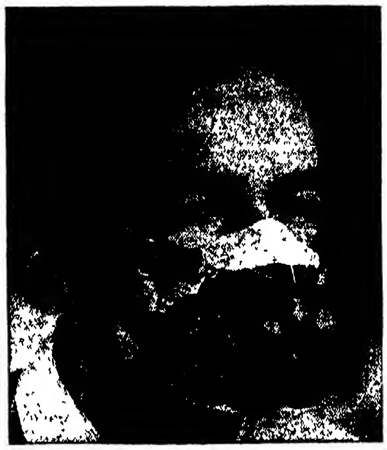
The developments in the field of sulfa drugs mark one of the most brilliant chapters in the history of medicine. These drugs have already proved their value in armies of the world in preventing gas gangrene, the ailment once more dangerous than bullets. In World War I the loss of arms and legs from infection was frequent and eighty per-

cent of the soldiers with perforated abdominal wounds died. Following the attack on Pearl Harbor not a man lost an arm or leg from infection and virtually all who survived shock recovered

RESPIRATOR

Cartridge Type for Nuisance Gases

COMPLETE protection against paint and lacquer sprays, chemical fumes, smoke, and so on is afforded by a new cartridge-type respirator known as Dupor No. 10. Different types of cartridges, for differing filter purpose, are available for this mask The cartridges are easily distinguishable by their color so that the workmen can always select the correct cartridge for the job.



Cartridges come in colors

The molded rubber face piece gives air-tight fit while the adjustable head band holds the respirator firmly in place.

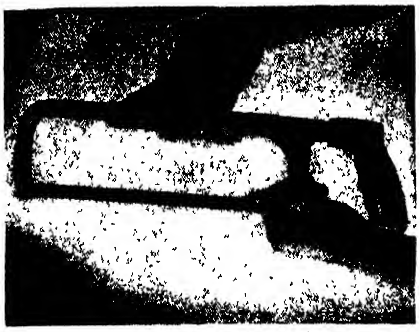
HACK SAW

Has Quick-Action Lever Lock

A CAM-ACTION lever-lock sets up and releases the blade in a new type of hack saw frame, in which loose blade studs and threaded tension devices have been completely eliminated with the result that blades can be replaced or repositioned in a fraction of the time required with frames of conventional design.

Straighter cuts and reduced blade breakage are claimed to result from the extremely high tension which this new Star frame puts on the blade This high tension is possible because the frame is made of heat-treated spring steel. A gun-metal finish insures high resistance to rust and all other forms of corrosion.

The frame may be adjusted for 8-,



The lever locks the saw blade

10-, or 12-inch blades by pulling out a single pivot pin to its open position, sliding the frame forearm in or out to desired length, and snapping the pin back into place. Blade may be re-positioned to face in any of four directions by placing it over either of two sets of fixed pins which are integral with frame

• • •

PAY—The median annual income of members of the chemical profession in 1941 was $3,364, it is disclosed by a survey just completed by a committee of the American Chemical Society. Fifty percent of the profession earned more than this figure and 50 percent less

• • •

CONFERENCE CONTROL

Made Possible by New Intercommunication System

An intercommunication system which provides many new features not available in any other one system is known as the Super-Chief With an installation of these units, it is possible for any number of stations to hold a private conference without interruption or eavesdropping from other stations outside of the conference group Also, by means of ingenious control switches, it is possible to maintain one-way automatic transmission which

Intercommunication station unit

is especially effective for dictation and for recording of conferences.

The units of this intercommunication system are provided with amplifiers of sufficient power to permit operation without a falling off in efficiency with the units as far as 3000 feet from each other. Each station is equipped with individual volume control and optional equipment includes an earphone for use where privacy is essential

Industrial Growth

New Products & Processes That Reflect Applications of Research to Industrial Production

SIGNAL LIQUID

Hardens to a Surface That Melts Sharply

FOR USE in any application where fairly accurate determinations must be made of temperatures, a new liquid material has been developed which is applied to any surface by a brush. This liquid dries quickly to form a smear on the surface that melts sharply when the temperature of the surface reaches the rated temperature of the material. After cooling, the smear forms a glossy mark, different in appearance from the original, which indicates that the signal is no longer operative. This mark can be wiped off the work surface.

This liquid material, known as Tempilaq, is available for signal temperatures in 25 degree steps from 125 to 350 degrees, Fahrenheit, and in 50 degree steps from 350 to 1600 degrees, Fahrenheit.

POWER PLANTS

Searchlight Equipment Undergoes Test

BEFORE portable power plants for the operation of United States Army searchlights are sent out into the field, they are rigidly tested in the factories which produce them. Shown under such test in an accompanying illustration are a group of such power plants in one of the General Electric factories. Most of those shown are designed to supply current in the field for the operation of 60-inch, 800-million candle anti-aircraft searchlights.

WEAR GAGE

Makes Indentation Which Is Measured Microscopically

AN OPTICAL instrument, which can be used on internal or external flat or

Wear gage of many uses

curved surfaces to measure wear, employs a microscope to make comparison measurements of diamond-shaped indentations. After these indentations are

Soon to be furnishing power for anti-aircraft searchlights

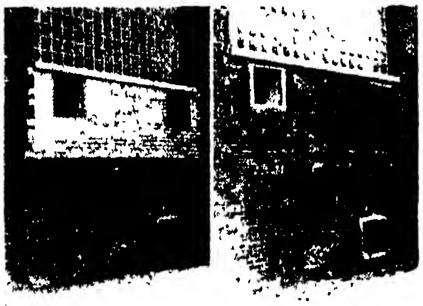
made with a special indenter, the base length of them will change as the surface wears. Measurement of this change by means of the microscope makes it possible to detect a minimum wear of 000015 of an inch, or a maximum of 0014 of an inch

This new gage can be used on cylinders, spheres, or flat surfaces. Typical applications are measuring the wear in engine cylinders and on pistons, crankshafts, and other similar parts where accurate wear determinations are essential to research

BRICK AGER

Solution Colors Brick to Camouflage New Work

THE UNSIGHTLY appearance of new brick work, when it is combined with old work as in a repair or rebuilding job, can be quickly and easily masked by the application of an aging solution. This solution, mixed with water,



Before and after applying camouflage

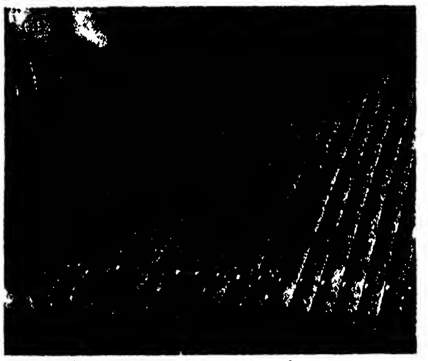
is sprayed or brushed over the surface. The two accompanying illustrations are from photographs made only a few minutes apart. Between the two exposure times a coating of Justrite brick aging solution was applied to the repaired surface, effectively "camouflaging" it to blend with the older surface.

NON-SLIP

Grid Gives Protection Against Falls

DESIGNED to eliminate hazardous conditions under foot in places where excessive water, oils, or other liquids make floor surfaces slippery and unsafe, a new wooden grid is giving satisfactory service. Made of oak, the non-slip feature of Orco-Grid is obtained by bonding alundum abrasive aggregate to the walking surface of the grid pieces.

A composition known as "Valini" is used to bond the aggregate to the surface of the grids. The abrasive aggregate and the bonding composition are not affected by alcohol, gasoline, creosote, S.A.E. 10 oil, water, and



Abrasive insures sure footing

other commonly used solvents Temperatures ranging from 55 degrees below zero to 300 degrees above zero, Fahrenheit, do not affect the aggregate or the bond

FUEL METER

Uses Synthetic Rubber as Shaft Protection

SYNTHETIC rubber has solved a major problem in helping to assure the safety of Army and Navy fliers; Chemigum is being used in the rotors within fuel lines of war planes to show each pilot how fast his fuel is being consumed. This is important in order that each pilot may balance his rate of usage against his supply

The fuel-meter rotor is mounted directly in the center of a plane's major fuel line, with the center shaft parallel to the flow of the gasoline. The stainless-steel shaft of the rotor is covered at each end with a sheath of Goodyear's Chemigum to resist the solvent action of the gasoline; natural rubber would swell and possibly clog the fuel line.

In the center of each rotor is a bushing of magnetized metal Propeller blades on the outside of each rotor force the roller to revolve as the flow of gasoline strikes them. Thus the rotor, revolving inside the metal fuel line, acts in the same manner as an armature, generating electrical im-

pulses which are transmitted by wires from the fuel line and the rotor's mountings to the airplane's instrument board.

Naturally, as the flow of fuel increases, the strength of the electrical impulses is raised, which, in turn, reflects on the calibrated dashboard dial that records the volume of fuel usage

SPEED DRIVER

Can Speed Up Hand Assembly Jobs

A NEW high-speed ball bearing driving tool, known as the Aero Tool Speedball Driver, drives screws, countersinks, or removes burrs. Replaceable tips, conveniently stored in the recessed handle, gives the tool a wide variety of uses. It can be supplied in

A variety of tips are used

several shapes for special work with tips for Phillips screws, slotted-head screws, set screws, or for burring and countersinking jobs A tapered shank on the tip allows for easy removal but will not permit the tip to turn in the tool.

GOLD ALLOY

For Use in Small Parts Manufacture

ELECTRIC contacts, instrument bearings, and so on can readily be made from a new precious-metal alloy containing gold, platinum, and palladium, recently announced by J. M. Ney Company. This new alloy, which can be drawn, rolled, machined, soldered, and welded, fuses at 1985 degrees, Fahrenheit, and has an annealed hardness of 180 Brinell.

FIBER CONDUIT

Is Replacing Metal in Many Applications

IN VIEW of the metal shortage, great interest has been shown in the possibilities of fiber conduit such as Bermico, in which wood cellulose fibers are scientifically built up and heat-treated to form rugged tubes with a solid, homogeneous wall structure. These tubes are then impregnated by a special process to produce a chemically inert, light weight pipe with high mechanical strength and water resistance.

Millions of feet of Bermico are put under ground each year for the installation of electrical cables. Lately Bermico fiber conduit has been used in place of critical metal conduit. Another new application is for inside drain pipe to carry off rain water. Bermico is also reported as being used as a protective jacket to prolong the life of metal pipe exposed to corrosive action of liquids or gases.

PAPER BURLAP

Has Similar Uses to Fabric Which It Simulates

AVAILABLE in rolls and measuring from 30 to 64 inches in width, a new woven paper burlap is being marketed for application in most of the services for which fabric burlap has been used Bags, wrapping, backing for carpets and rugs, upholstery, and seat covers are a few representative examples of the possibilities of this new material made by the Matthias Paper Corporation.

INSULATOR-MARKER

Made of Plastic Tubing for Wire Terminals

SHORT lengths of extruded plastic tubing are clearly marked with letters and numerals to perform two jobs; they serve as insulators of terminal connections and as wire markers. Where lug insulation and wire identification are required, they speed assembly by eliminating other means of identification.

The tubing from which these new combination insulator-markers are made has high dielectric strength Smooth inside surfaces permit quick application over wires and lugs. Legible numerals of the customer's choice are printed on the tubing with an ink that has resistance to chemicals, water, and oils equal to that of the tubing itself.

HAND WHEELS

Cast from Phenolic Resin, With Metal Inserts

CUSTOM fabricated to the user's requirements, a new line of plastic hand wheels for use on machinery of various kinds has been developed by the Colonial Kolonite Company. These wheels are cast from a phenolic resin; hence, priority ratings of A-1-K or better are necessary.

Metal inserts for these new hand wheels are shrunk in under heat after fabrication, the metal parts being supplied by the customer.

Most Powerful Dive-Bomber

New American Aircraft Excels in Every Respect Any Other Dive-Bomber Ever Built

ALEXANDER KLEMIN
Aviation Editor, Scientific American
Research Professor, Daniel Guggenheim School of Aeronautics, New York University

So much has been written about the German Stukas that many have come to believe that the Germans not only invented dive-bombing, but that they excel at this effective fighting method. As a matter of fact, the American Navy originated dive-bombing and our dive-bombers are superior to anything built anywhere in this class of aircraft.

The latest, most powerful, and most ominous dive-bomber is the Curtiss-Wright XSB2C-I, which is a mid-wing design and which carries two men for its crew. Military necessity prevents much information being revealed, but we are glad to learn that the machine will be faster, will have a greater range, and will carry a greater load of bombs than any other craft of its type in the world. It is powered with a 1700-horsepower Wright Cyclone engine, the wings have either fixed or movable slots at the tips, and a three-bladed controllable pitch propeller will absorb the power of the Cyclone.

EXPERTS ABROAD

Promote Co-Operation in United Nations' Aircraft Production

From the point of view of our aircraft program, it is most encouraging to see how closely Americans and British are co-operating. A feature of such co-operation is the exchange of missions, whose personnel is composed of aircraft manufacturers—not politicians. When people like T. P. Wright, of the Aircraft Division of the War Production Board; Ken Ebel, chief engineer and test pilot of Glenn Martin's; Philip G. Johnson, the energetic president of Boeing Aircraft; J. Carlton Ward of Fairchild Aviation; and other equally well qualified experts visit the aircraft factories of Great Britain, they return with much useful information, both military and industrial. In turn, they serve to energize the English manufacturers.

Mr. Wright, on his recent return, reported impartially on the merits and demerits of British methods. Their factories are underground, in many cases, with a number of plants scattered in a given district to feed a central assembly plant. This makes for safety against bombing, but does not make for better volume. Again, English machine-tool equipment is more obsolescent than ours and single-purpose machines, which we take for granted, are less frequent in England. On the whole, productivity per man is less than in the United States.

But Mr. Wright did not give us superiority on all points. Thus, British working hours are about 15 percent longer than in the United States. Relationships between labor and management are more cordial. There are no material bottlenecks to be found. On the contrary, materials flow smoothly and their control is far more efficient than with us. When the Deputy Director of the Aircraft Division of the War Production Board is expert enough and broad-minded enough to make such observations, we can only compliment him on his wisdom, and ourselves on our good fortune in having such a man in this vital Washington post.—*A.K.*

• • •

LUMBER—Blue stain in sapwood lumber is caused by tiny threads of living organisms which permeate the wood cells. Although the threads within the wood are brown, they impart a blue to blue-gray color by refracted light.

• • •

TURNTABLE

Made in Portable Form, for Use on Any Airport

The activity of an airport, as far as ground movement of the airplane is concerned, is concentrated at the Administration Building loading platform. And as plane traffic increases, so does congestion grow at the loading platform; the difficulty of finding space in which to turn planes around increases in like measure. In an attempt to meet this difficulty, fixed or permanent type turntables have been in

stalled at Floyd Bennett Field, Long Island, and at the National Airport in Washington. These turntables require reinforcement in the concrete or pavement adjacent to the turntable pit, and also provision for draining the pit.

Now, the International Stacey Corporation, working under the sponsorship of the Civil Aeronautics Authority, has produced a portable turntable which can be moved about the airport as required (thus relieving congestion). This new unit needs no pavement reinforcement and is self draining.

The portable turntable is five feet six inches in diameter, and only two inches in height. Seals protect its huge steel ball bearings against dust and dirt. The whole unit weighs only 700 pounds and requires no anchorage to the pavement surface. This turntable has performed successfully under a single wheel load of 20,500 pounds with very little deflection of the top revolving plate, and it has already given excellent trial service at the Washington airport.

The handling of cargo for the airlines, the construction of suitable cargo terminals, the installations of hand-cart and conveyor systems, are all just in the offing. This portable turntable is but one of the many devices which airport engineers will develop and which will help to handle the commercial air cargo that all authorities so confidently expect to come after the war. For military purposes air cargo is already being carried on a vast scale.—*A.K.*

SCRAP SALVAGE

In Aircraft Industry Is On Scientific Basis

GREAT credit is due to the Wright Aeronautical Corporation for working out a complete plan for salvaging tons of vital scrap—steel, aluminum, and other high grade materials used in the construction of airplane engines. Moreover, this scrap is secured in such a condition that it can be quickly reapplied to the war effort, and is sent immediately to steel companies, shipyards, tank manufacturers, smelters, and the like

The plan has the vital advantage of segregating the various metals just as fast as they are removed from forging or casting by lathe, drill, or milling machine. Machine tools, ranging from small boring machines to massive turrent lathes, have bins attached which catch and hold all shavings and chips or whatever waste is produced. Salvage collectors wheel large boxes up and down the factory aisles, gathering a special type of metal and, to make sure that there is no mix-up, the containers are identified with the corresponding machine tools by a foolproof color-marking system. Containers are marked with a specific color for each metal, the coloring being in the form of a large "V" painted on the side of the box The men employed, some of whom have been appointed "monitors," give full co-operation.—*A.K.*

CREW TRAINER

Contains Major Aerodynamic Features of Combat Planes

IT is an immense step from primary basic training to the piloting of a huge multi-engined bomber There is another great step from the individual effort of the pilot to the coördinated team-work of the crew of a bomber The Army Air Forces have taken due cognizance of these facts and met the situation by development of the AT (Advanced Training) Crew Trainers Such an advanced crew trainer has been designed and built for the A. A F. by the Boeing Airplane Company, and the Boeing AT-15 was probably the first training plane specifically designed and equipped for the integrated training of pilots, co-pilots, bombardiers, navigators, and gun crews In reality, it is a small, perfectly equipped bomber, with everything provided to give members of the crew complete training in their duties as individuals and as members of a team.

All the military gear of a bomber is included—bomb racks, power-operated gun turrets, regulation bombardier's position in the plastic enclosed nose, and full radio and navigational facilities The fuselage is constructed of mild steel tubing with wood fairing and fabric covering

Wings and tail surfaces are of wood with plywood covering. The wing span is approximately 59 feet and the overall length is 42 feet. With two Pratt & Whitney engines of moderate power, the top speed is well over 200 miles an hour.

Specifically designed and equipped for bomber crew training

ELECTRIC EYE

Controls Warning Lights on Aviation Hazard

SOME two miles from La Guardia Airport, an "electric eye" has been installed on a 125-foot standpipe The

Photo-cell airport guardian

"electric eye," as the photoelectric device has been nicknamed, makes use of one phototube and three standard radio type vacuum tubes At the approach of darkness or fog this device will turn on red warning lights.

Relays of this type are not new. They have been used for the control of street and highway lighting and for floodlighting and spectacular devices; it is their application to airport service that merits noting.—*A.K.*

ANTI-AIRCRAFT

Weapons, Both Secret and Announced

BRITISH merchant ships are reported to be using a rocket device that sends into the sky parachutes, which. when discharged from their small

shells, dangle long wires and entangle attacking airplanes. The mere fact that the device has been allowed to pass the censor is, however, an indication that its efficiency is perhaps mediocre Another, more powerful British anti-aircraft weapon has remained secret. The Government was about to describe it. A newspaper, *The Daily Mail*, pleaded for censorship, which constituted an analogy to the man-bites-dog story *The Daily Mail* was perfectly right in insisting on secrecy, and the new weapon seems to be inspiring fear in attacking German raiders who often throw their bomb load down in open country and race back —A.K.

NATIONAL DEFENSE

How A Naval Battle Is Fought

(*Continued from page* 103)

and beneath its surface, staging raids against enemy shore installations, and — most important of all — covering landing operations, such as in the Solomons, and such, again, as that in Northern Africa, in co-operation with the Army

The third main engagement in the Solomons, the Battle of Cape Esperance, occurred the night of October 11-12 Under cover of darkness a strong Jap force tried to repeat the practice of landing reinforcements on Guadalcanal

All classical standards aside, this battle was fought in the darkness of midnight and lasted for *27* minutes It was a duel of guns and torpedoes, between almost equal opposing forces It was a battle in which a trap was set by the United States force, including the now-famous cruiser *Boise*, of Captain E. J "Mike" Moran The Japs steamed straight into ambush

THE *Boise* alone fired 1000 rounds of 5 and 6-inch shells, nearly 40 a minute for the *27* minutes. She shared in the sinking of three Jap cruisers and three Jap destroyers. She was hit below waterline, her fires were out, and flames leaped mast-high. She was given up by her sister ships, but the crew of the *Boise* plugged holes with bedding, and patched her and pumped her so that she amazed all by steaming back into line at 20 knots two hours later. And, despite her own loss of 107 officers and men, she continued operation

The Japs fled

With the coming of daylight our planes followed the Jap flight and inflicted further damage on Jap vessels. The Japs lost at least eight ships sunk and three damaged. We lost one destroyer.

In the Battle of Santa Cruz Islands, the fourth main sea engagement in the Solomons, we lost one carrier and one destroyer. The Japs in the same engagement lost one battleship, three carriers, five cruisers, along with 100 planes destroyed and 50 "probables" The battle centered around a United States carrier task force which exchanged air thrusts with a strong Jap group northeast of Guadalcanal.

The Battle of Guadalcanal (being the official title of the fifth main sea-engagement in the Solomons) occurred November 13-15 The Japs again attempted to dislodge our forces in the Solomons. The Jap preparations this time were larger than ever. For weeks they had been assembling ships, planes, and troops in New Guinea, in the Northwest Solomons region

When the enemy had everything ready and assembled for the attack, three large forces moved in upon the Solomons They were met by our ships just after midnight of the 13th This was the battle wherein the Japs, in the darkness, got confused and fired on each other This was the battle, too, wherein the *San Francisco*, by steaming between the enemy lines and adding more confusion to the Japs, so distinguished herself that she later received the accolade.

Our planes fought all next day, and a new sea-action took place on the second night Warship slugged with warship On the morning of the 15th the Japs fled. Or at least the survivors fled, for the Jap losses included 25 to *27* ships sunk and 10 ships damaged. The sinkings included one, and perhaps two, battleships The United States lost two light cruisers and seven destroyers

In theory, then, it would seem that individuality on the part of the commanders, along with surprises on not doing the expected as taught in school, have as much to do with winning sea-engagements today as they always have —despite all the war theories ever written or studied.

It was the same in the days of John Paul Jones and the *Bon Homme Richard*. It was the same when the *Boise*, given up for lost, steamed back into line still firing and her commander saying: "Go after the biggest ones first" It was the same when the *San Francisco* steamed directly between the enemy lines at night, causing the Japs to fire on each other. It will be the same when. . . .

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with the names of available books, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for. Books listed in these columns may be ordered from our Book Department.

A MATHEMATICS REFRESHER

By A. Hooper

ANOTHER crutch book for the lame mathematician, and an excellent one—as proved by the fact that it has made learned mathematicians shudder (because it unbends and attempts to break down the usual barriers, and isn't conventional). Arithmetic, algebra, geometry, trigonometry, and a wee peek at calculus—these give the scope. After examining it, this reviewer sees no reason why a diligent student who never had previously studied mathematics could not derive much help from this book. It was prepared mainly to refresh aviation trainees whose high school mathematics was rusty. (342 pages, 5¼ by 7¾ inches, illustrated)—$2.60 postpaid.—*A.G.I.*

NEW COMMERCIAL AND TECHNICAL DICTIONARY

Spanish—English, English—Spanish

IN AN attempt to set a standard of terminology for technical and commercial words in Spanish, 50,000 words have been chosen and defined. Many engineers, importers, technicians, and soldiers will find that the information presented here will be invaluable on many occasions. A supplement gives conversion tables of weights, measures, and monetary units. (600 pages, 6½ by 9½ inches, unillustrated, thumb-indexed.)—$10.20 postpaid. —*A.P.P.*

JEWELRY, GEM CUTTING, AND METALCRAFT

By William T. Baxter

SECOND edition of a book which has been well received. The section on jewelry making has been rewritten and new material added. This book tells how, gives addresses of dealers in material and equipment and, in general, emphasizes the practical. (287 pages, 5½ by 8 inches, 170 illustrations.)—$2.85 postpaid.—*A.G.I.*

UNITED STATES SERVICE SYMBOLS

By Cleveland H. Smith and Gertrude Taylor

THE vastness and variety of war services and insignia are made simple, understandable, and far more interesting by use of this volume. To know the meanings and backgrounds of the symbols worn by American men and women fighting this war is to appreciate the whole picture far more thoroughly. The authentic information and hundreds of illustrations in color will identify members of the Army, the Navy, the Marine Corps, the Coast Guard, the Air Forces, the Women's Services, the U.S.O., Civilian Defense people, as well as medals, decorations, squadrons, regiments, and signal flags. (116 pages, 5 by 7¾ inches, lavishly illustrated in color)—$1.60 postpaid.—*A.D.R., IV.*

THE STEAM LOCOMOTIVE

By R. P. Johnson, M. E.

CONCISE, technical treatise on locomotive theory, operation, and economics for (mechanical) engineers. Author is chief engineer of the Baldwin Locomotive Works. Typical chapters: Tractive Force; Counterbalancing; Torque Diagrams; Locomotive Testing; High Speed Service; Repair Costs. Plain, unadorned, thoroughly businesslike work (even the cover is black like a locomotive) which makes no concessions to popular appeal. (502 pages, 6 by 9¼ inches, illustrated)—$3.60 postpaid.—*A.G.I.*

VOLES, MICE AND LEMMINGS

By Charles S. Elton

ECOLOGICAL study of a problem in popular dynamics, by the Director of the Bureau of Animal Population at Oxford University. Fluctuations in vole, or meadow mouse, and other mouse population are studied in relation to those of their predators in both old and new worlds (especially in Labrador Peninsula, from the very old Hudson's Bay Company records). (496 pages, 6 by 9½ inches, 21 illustrations.)—$10.10 postpaid.—*A.G.I.*

SHIPBUILDING BLUEPRINT READING

By Joseph L. Tomlinson

CONTENDING that skill, knowledge, and technique needed to *make* ship drawings are unnecessary to enable students to learn to read and interpret them, this author offers a practical home course on shipbuilding blueprint reading, minus close study of principles involved in marine construction. Thus he arrives at a simple explanation of skill in visualization, and understanding of symbols and abbreviations commonly found in ship prints. Preliminary sections are instructional, followed by test sheets in step-by-step

fashion. Author has background as shipfitter instructor with shipbuilding companies and vocational schools (208 pages, 8 by 11 inches; profuse with diagrams, drawings, blueprints)—$3.10 postpaid.—*A.D.R., W.*

STRUCTURAL GEOLOGY

By Marland P. Billings

SPECIALIZED textbook treatise, limited to that part of geologic science which deals with the principles, methods, and technique of determining and mapping local structural (three-dimensional) units. Adapted to readers who are already familiar with stratigraphy, paleontology, physiography Author is associate professor of geology at Harvard (473 pages, 6 by 8 inches, 336 illustrations)—$4.60 postpaid.—*A.G.I.*

RULES OF THE ROAD

By Lt. Robert A. McCoy, USNR, and Lt Davis N. Lott, USNR

NAVY and reserve officers, midshipmen and enlisted men, merchant marine officers and seamen, sea scouts and private yachtsmen will find this thorough explanation of every combination of lights or signals required under both International and Inland Rules of the Road both timely and valuable (121 pages, 6 by 9 inches, 45 full-page plates.) — $2.10 postpaid. — *A.D.R., W.*

FOUNDATIONS OF ASTRONOMY

By W. M. Smart

PRACTICAL, rather than descriptive, astronomy is the main content of this work Content: geometry of the sphere; celestial sphere; right ascension, mean time; solar system and law of gravitation, refraction; parallax; aberration, precession and nutation, determination of Earth's position; Moon; eclipses, stars, stellar motions; clusters and nebulae; telescopes This book will repel readers who seek attractiveness, as it is bleak; but will attract those who prefer bleak, compact, mathematical treatment without concessions to interest or wordiness (it surely isn't garrulous!) It is the text used in first year astronomy in Britain In mathematics it does not go beyond trigonometry. Author is Professor of Astronomy at Glasgow. (208 pages, 5½ by 8½ inches, 115 figures, no pictures)—$4.30 postpaid.—*A.G.I.*

COME AND GET IT!

By George W. Martin

THE appeal of outdoor cooking and outdoor eating grew apace with America's automobile ownership—these rubber-less and gasless days the relegation of the art of outdoor culinary achievements to the back-yard hasn't lessened that appeal Beginning with a comprehensive discussion of outdoor fireplaces, stoves, ovens, fuels, and personal equipment, the reader will learn much that is helpful about preparation of delicious meats, fowl, fish, shellfish, eggs, gravies and sauces, veg-

The Editors Recommend

Best Sellers in Science

PLASTICS — *By J. H. Dubois.* Meaty information on the whole general subject of plastics, presented in narrative form for easy reading. Tabulations of properties of plastics, plus basic design information, for laymen and technicians alike. **$3.10**

CHEMISTRY — *By Gerald Wendt, Ph.D.* Chemistry made easier by a presentation that is intermediate between popular works and classroom texts This book contains the main substance of a first-year college chemistry course, giving the reader better than a sketchy background in this important science **$2.35**

HOW TO READ ELECTRICAL BLUEPRINTS — *By Gilbert M. Heine and Carl H. Dunlap.* A chapter on how blueprints are made, plus nine other sections, each of which is devoted to a specialized part of the electrical field, from bell and signal wiring through motor control diagrams to power station blueprints. **$3.10**

GET TOUGH! — *By Capt. W. E. Fairbairn* How-to-win-in-hand-to-hand-fighting directions, by a man who really knows rough-and-tumble methods that are *not* "clean" fighting but *are* designed to win. **$1.10**

PLANE TRIGONOMETRY MADE PLAIN — *By Albert B. Carson.* The emphasis in this book, by an author who has tried to make the subject as painless as possible, is on practical applications rather than on mental gymnastics. A good book for the home user who wants to brush-up on trig **$2.85**

TECHNIQUE OF PLYWOOD — *By Charles B. Norris.* Technical information on all phases of plywood manufacture and use, compiled for engineers, designers, and users of plywood. Important to many phases of wartime housing and manufacturing problems **$2.50**

FUNDAMENTALS OF RADIO — *By Jordan, Osterbrock, Pumphery, and Smeby.* With this one volume alone, and with some diligence of application, it is possible to obtain a thorough grounding in radio principles. In thoroughness of treatment, with due respect for the needs of the reader, this book is outstanding. **$5.10**

THE TRISECTION PROBLEM — *By Robert C. Yates.* Embodies mathematician's answer to would-be trisector. Gives chief dependable data on this never ending dispute. Compact, crisp, concise. **$1.10**

ELEMENTS OF ORDNANCE — A textbook prepared for cadets of the United States Military Academy. Covers manufacture, the chemistry of explosives, types of weapons, mathematics of ballistics, etc. **$6.60**

AIRCRAFT INSTRUMENTS — *By George Ellis Irvin.* All types of instruments for aircraft use described for students, pilots, inspectors. Fundamentals, instructions. **$5.10**

FIRE FROM THE AIR — *By J. Enrique Zanetti.* Pertinent facts regarding incendiary bombs. History, modern types, materials, and the strategy and tactics of their use in modern warfare. **$.60**

MACHINERY'S HANDBOOK—*Eleventh Edition.* "Bible of the mechanical industry," enlarged to 1815 pages of latest standards, data, and information required daily in the shop and drafting room. **$6.10**

PROCEDURES IN EXPERIMENTAL PHYSICS — *By John Strong, Ph.D.* A wealth of useful data of a practical kind for the constructor, experimenter, and skilled craftsman. **$6.80**

STEEL SQUARE POCKET BOOK — *By Dwight L. Stoddard.* Practical methods of using the carpenter's steel square for layout work of all kinds. Time-tried methods used by two generations of carpenters and found both rapid and accurate **$1.00**

MATHEMATICS — ITS MAGIC AND MASTERY — *By Aaron Bakst.* Investment in approach to algebra, geometry, trigonometry, with time savers **$4.10**

WORKING WITH THE MICROSCOPE — *By Julian D. Corrington.* For the serious beginner. Explicit, practical. **$3.60**

TOOL MAKING — *By C. B. Cole.* Instructions for making and using all kinds, from personal tools to arbor presses, lathes, planers, etc., in different metals. **$3.60**

THE ELECTRON MICROSCOPE — *By Burton and Kohl.* A well-written account of this newest tool of science, with all technicalities explained for complete understanding by average persons. **$3.95**

GETTING ACQUAINTED WITH ELECTRICITY — *By Alfred Morgan.* Phrased in layman's language and aimed at the average man who finds himself somewhat bewildered by electrical gadgets in his home, his automobile, and his place of business, the text of this book deals only with basic principles. **$3.10**

MILITARY BASIC COURSE — *By Capt. Frank X. Cruikshank.* Complete story of Army operations in handy pocket volume. Fabrikoid binding. **$1.35**

A MARRIAGE MANUAL — *By Hannah M. Stone, M.D., and Abraham Stone, M.D.* A practical guide to sex and marriage, covering fitness for marriage, mechanism of reproduction, prevention of conception, and similar vital subjects. Answers questions most often asked these authors by their consultants. **$2.60**

THE ADVANCING FRONT OF MEDICINE, *By George W. Gray* — Summary of the high points of our present-day knowledge of the nature of disease Alimentation, high blood pressure, the sulfa drugs influenza, allergy, insanity, sleep, pain, drink, smoking, anxiety, cancer, aging. A truthful picture of the status of medicine **$3.10**

AUTOMATIC ARMS — *By Melvin M. Johnson and Charles T. Haven.* Comprehensively covers machine guns, machine rifles, sub-machine guns pocket pistols, shotguns, sporting, military rifles in automatic classification. **$5.10**

BASIC FIELD MANUAL, INFANTRY DRILL REGULATIONS. Practical working manual for commissioned, non-commissioned officers. **$.50**

HANDBOOK OF CHEMISTRY AND PHYSICS — A classic reference book recently revised and brought up-to-date to keep pace with recent research. Includes material on all branches of chemistry, physics and allied sciences. Used in laboratories and by engineers throughout the country. Flexible binding. 2503 pages. **$3.60**

ATOMIC ARTILLERY — *By John Kellock Robertson.* Electrons, protons, positrons, photons, neutrons, and cosmic rays, all described for the layman in plain language. Also transmutation of the elements and the manufacture of artificial radio activity. **$2.35**

● The above prices are postpaid in the United States. Add, on foreign orders, 25¢ for postage on each book, except as noted. ●

- -

For Sale by: **March, 1943**

SCIENTIFIC AMERICAN, 24 West 40th Street, New York City

I enclose $...... for which please forward at once the following books:

....

....

Name ....

Address ....

Write us for information on books on any subject. We can supply any book in print

etables and cereals, soups, breads and flour foods, beverages, and even such luxuries as deserts. Packed with splendid recipes for picnickers, campers, hunters, and all out-of-door eating fans. (189 pages, 5¾ by 9 inches, many drawings, index.)—$2.10 postpaid.—*A. D. R, IV.*

WILLARD GIBBS

By Muriel Rukeyser

As THE years move on, science steadily elevates the late Willard Gibbs higher and higher. An obscure, shy man, scarce known to his neighbors, likewise unknown to the world outside his quiet limited daily radius at Yale, performed mathematical miracles that have proved to be basic beneath chemistry, and physics, and biology and, beyond these, chemical industry. Gibbs, the almost unknown, is seen today to have been one of America's few really great scientists. Among his biographies the present one, widely acclaimed by reviewers, is turning out to be equally preeminent (463 pages, 6 by 9 inches, 6 illustrations.)—$3.60 postpaid —*A.G.I.*

MATHEMATICS FOR READY REFERENCE

By H. M. Phillips

READERS of this book can use it as a reference work as needed or as a text from which to glean a comprehensive knowledge of the whole subject of mathematics. The method in which the text is presented in numbered sections makes reference particularly easy. (224 pages, 5½ by 8 inches, a number of drawings, thoroughly indexed.)—$2.10 postpaid.—*A.P.P.*

WOODCRAFT

By Bernard S. Mason

COMPREHENSIVE, encylopedic on all phases of campcraft, woodcraft, and crafts of the woods. Excellent reference and guide to camp counselors, club leaders, and individual—old or young—who like life in the open. Author has had a lifetime of experience in his subject, is acknowledged by Ernest Thompson Seton as a "master" (580 pages, 5¼ by 9 inches, indexed, numerous photographs and drawings.)—$2.85 postpaid.—*A.D.R.*

HOW TO PLAN A HOUSE

By Townsend and Dalzell

PRACTICAL working manual from which the prospective—or today, at least, optimistic—house builder may gain access to the underlying principles of planning which architects know, but which so many amateurs, carpenters, builders do not know, or else ignore to the detriment of houses. This book gets right down to cases and gives tangible details—it isn't merely vague and general. After studying it thoroughly, the reader should emerge with an enhanced respect for architects—and in the end probably will hire one, but will understand, anyway. (525 pages, 5½ by 8¼ inches, heavily illustrated.)—$4.60 postpaid.—*A.G.I.*

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

PORTABLE ELECTRIC DRILL, ITS PROPER USE AND CARE is a handbook specifically aimed at operators of various types of hand drills. The text describes and illustrates the use and care of different types, showing many of the wrong methods which should be avoided for long and efficient drill life. *Black and Decker Manufacturing Company, Advertising Department, Towson, Maryland—Gratis.*

INDUSTRIAL SUB-ZERO MACHINES is an eight-page illustrated folder which describes various types of refrigeration equipment for such industrial purposes as rivet storage, expansion fits, aging and processing, and testing. *Kold-Hold Manufacturing Company, 424 North Grand Avenue, Lansing, Michigan.—Gratis.*

HOW TO INCREASE TOOL LIFE is a 24-page illustrated booklet which describes a method of increasing the life of cutting tools by fine-finishing of the cutting faces during regrinding. By such methods it is claimed that production has been increased as much as 400 percent for milling cutters and 66 percent for punches and dies *Norton Company, Worcester, Massachusetts—Gratis.*

RECTIFIERS FOR ELECTROPLATING, ANODIZING AND ELECTROTYPING is a bulletin which describes in detail a line of copper oxide rectifiers, their construction, operation, and operating characteristics. Profusely illustrated with photographs, charts, and diagrams. *Hanson-Van Winkle-Munning Company, Matawan, New Jersey.—Gratis.*

A. C. WELDERS is a 12-page booklet which compares the advantages of A.C. and D.C. welding and shows how welding speeds can be increased and power costs decreased. *Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.—Gratis.*

PORTABLE FLEXIBLE SHAFT MACHINES is a 30-page booklet which describes and illustrates a wide range of machines of this type. Also illustrated are some of the attachments and accessories which are available. *R. G. Haskins Company, 615 South California Avenue, Chicago, Illinois.—Gratis.*

WHAT OF TOMORROW? is a 26-page folder which is presented as an anlysis of the possible trend of future events as prepared by a philosophical and educational fraternity. *The Rosicrucian Order, Rosicrucian Park, San Jose, California.—Gratis.*

SOLDERLESS WIRING DEVICES is a 32-page catalog devoted entirely to illustrations, descriptions, and specification details of a group of wire terminals and connectors, together with their application tools. These devices have been developed specifically for aircraft usage, but are adaptable to many other electrical problems. *Aircraft-Marine Products Inc., 286 North Broad Street, Elizabeth, New Jersey—Gratis.*

THE EVOLUTION OF THE SCREW, by Herbert Manchester, is a 22-page booklet which describes the historical development of the screw thread from its earliest known form up to those of the present day. *Parker-Kalon Corporation, 200 Varick Street, New York, New York—Gratis.*

THE STORY OF RESEARCH is a 20-page illustrated booklet which describes briefly but quite comprehensively the business of research as it is conducted by one of the largest industrial organizations in the country *General Electric Company, Department 6-201, Schenectady, New York.—Gratis.*

HANDBOOK OF SPECIAL STEELS is a 128-page manual presenting in text and tabular form the purposes and uses of a wide variety of steels, including tool, Nitralloy, stainless, electrical, and carbon steels. *Clark W. Green, Allegheny Ludlum Steel Corporation, Brackenridge, Pennsylvania—Gratis.*

PROTEKTOL is an eight-page pamphlet describing an industrial stripping lacquer which has been developed for use as a protective coating on polished metal, glass, or ceramic surfaces. This protective film, which prevents damage to surfaces during handling and fabricating, is easily removed *Interchemical Corporation, 75 Varick Street, New York, New York.—Gratis.*

NEW FIELDS FOR AMERICAN AGRICULTURE is a 53-page pamphlet giving data on growing small items formerly imported but no longer available due to the war· lavender, paprika, pyrethrum, perilla, rape, eucalyptus, camphor, cinchona. *National Farm Chemurgic Council, 50 West Broad Tower, Columbus, Ohio—50 cents.*

MICROMAX THERMOCOUPLE PYROMETERS is a 56-page illustrated catalog giving information about available instruments--indicators, recorders, and controllers—and about the thermocouples and accessories which are used with them. *Leeds and Northrup Company, 4934 Stenton Avenue, Philadelphia, Pennsylvania.—Gratis.*

AIR CLAMPS is a four-page illustrated folder describing a number of different types of air clamps for industrial machine tool use, ranging in size from a new midget type to larger models delivering pressures of from 80 to 1800 pounds on a line pressure of 100 pounds. *Mead Specialties Company, 15 South Market Street, Chicago, Illinois—Gratis.*

HOW TO HARNESS A CONFERENCE, by Don Herold, is a humorous approach to an ever-present business problem. It gives suggestions as to how to call conferences and how to conduct them, using printed forms which keep the whole business "on the beam." Please request this booklet on your business letterhead. *Hammermill Paper Company, Erie, Pennsylvania.—Gratis.*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

Figure 1: **Richardson's 18-inch**

IDEAL hobby for elderly people is telescope making. Equally ideal for telescope making are elderly people, for these have long since discovered the necessary patience and tenacity. E. G. Richardson, 1238 Broadway, San Gabriel, California, is 79 years young and, in sending the photograph (Figure 1) of his 18", $f/7$ reflector, he says he has ridden the hobby for five or six years and made mirrors from 6" up, also a 5¼" refractor and seven 6" and two 12½" flats.

Asked to give further detail about the 18" telescope, which is mounted as proposed by Porter in "A.T.M.", page 139, he writes: "Most telescope drives shown in the "A.T.M." books show the motor on the foundation or the frame of the telescope. I have tried that and attempted to smother the vibration, or rather cut it off from the telescope, by various kinds of pads and vibration insulators, but always found an annoying slight vibration, especially in some positions of the telescope, that interfered with sharp vision. So I have put my synchronous motor in a little two-story 'dog house' located on one side of the telescope platform just visible at the right in the photograph. The motor is mounted on a block of concrete which sits on a hole filled with sand. It is belted to a reduction gear which is on its own separate foundation, and the gear to a shaft which runs through a conduit under the platform and is geared to the worm which drives the large worm gear at end of the polar axle. I have absolutely no trouble from motor vibration

"The upper story of this little house opens onto the telescope platform and in it I keep star maps and the odds and ends that one uses about a telescope. The switch-controlling motor is also here.

"An accessory that is rather important with so large a telescope is the observing step platform, which the photograph shows beside the telescope. At first I used an ordinary 12' stepladder, but it is surprising to note the number of persons who are more or less timid when they climb a few feet off the ground, especially the ladies So I built the step platform. The steps are 10" wide and there is a strong rail on each side. You stand on the step that suits your height, lean on or grasp the rail, and take a look. You are relaxed and comfortable Much of the time you are looking downward, the most comfortable position, and the step is so solid that the most timid feel no fear. For convenience in moving around, the two legs are provided with large casters. You grasp the lower ends of the rails and push it around like a wheelbarrow.

"Are there any advantages in a large telescope? My experience is that when the seeing is good you get just that much more illumination and see better and more, but when the seeing is poor the big telescope gives no gain Often, in fact, a smaller instrument will show more."

THE LATE J. H. Hindle, of England, was one of a minority of amateur telescope makers who prefer machines to hand work Figure 2 is a clean-cut machine he was building when the war intervened. It never was completed. Hindle sent no descriptive data, but a close study of the photograph will afford useful ideas.

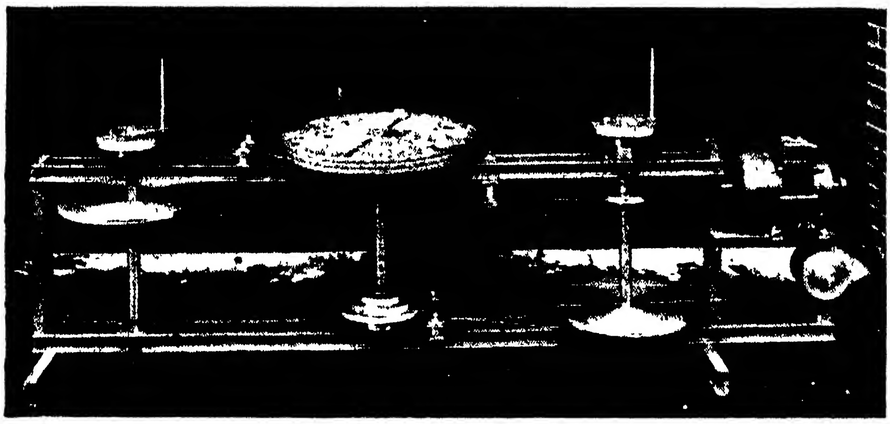


Figure 2: **Hindle's uncompleted machine with rope drive**

Hindle's machines for grinding and polishing embody a principle in which the mirror rides on top, just as in hand grinding, and is free to rotate of its own accord and does so rotate. Earliest origin of this idea, so far as is known, is the machine of Lord Rosse, described in Sir John Herschel's old volume, "The Telescope," dated 1861 Here it is the iron tool which rides on top (KL, Figure 3), mirror being beneath and immersed continually in water to within an inch of its surface. M is a round disk of wood connected with the polisher by strings hooked to it in six places, Sir John Herschel explains "The bar DG," he adds, "opens into a ring which fits the polisher nicely, but without tightness, so that the polisher turns freely around." Thus Hindle's machine traces pretty clearly to the younger Herschel's.

Figure 4 also might have been the inspiration of the drill-press grinding machine described by Hindle in "A.T.M.", page 219, and is the old Lassell machine described by Sir John Herschel in the book named above. Amateur telescope makers as a class are too mechanical to need all the lettered details of this old drawing explained, except possibly that the gear O is fixed and the sector S is concentric with the axle P, though in bad perspective in the odd old drawing. It is

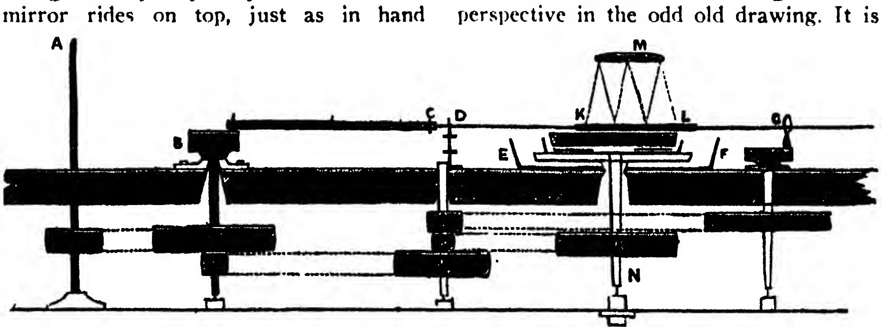


Figure 3: **Was this the genesis of the free-floating principle?**

hollow, and pinion T is adjustable anywhere along its groove. Hollow crank arm I' is also adjustable "By this mechanism," Herschel states, "it is evident that the pin [which drives the polisher J] will be carried circularly around a point which is itself maintained in circular motion"

Hindle's adaptation of this old principle was an improvement, in that he eliminated its rather Rube Goldbergish characteristics, and for them substituted more practical simplicity.

As all amateur telescope makers know, you can saw glass with wet Carbo and the edge of a strip of sheet metal. The same procedure works with stone. In

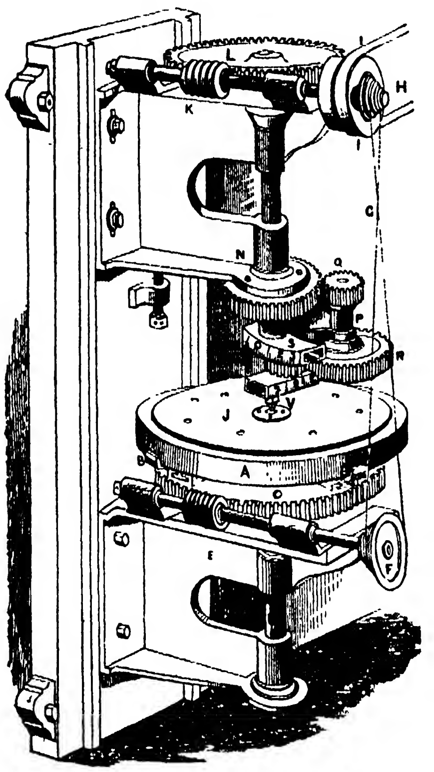


Figure 4: Lassell's machine

making the stone sundial shown in a temporary mock-up in Figure 5, your scribe sawed out its two 1" x 14" x 18" slabs of dense Devonian flagstone using No 60 Carbo with the back of a one-man crosscut saw, each cut requiring about an hour A drip-can was rigged up, a mound of Carbo was poured out near the cut, and this was fed in with the aid of a stick of wood as the right hand kept the saw moving (In this instance, the owner of the saw, too distant to see clearly and ignorant of our familiar sawing technique, thought the stone was being sawed with the toothed side, and fainted)

The uneven slabs were worked down with an old glass tool and coarse Carbo with ample elbow-grease, then fined with some of the familiar Carbo series

The gnomon is a solid casting of bronze made and contributed by Fred. B. Ferson, Biloxi, Mississippi, author of the chapter on molding and casting in "A.T.M.A"

Diagonal lines for each 15-minute time interval from 7 to 11 A.M. were incised with the edge of a piece of sheet metal and Carbo. As they shallow up at the

ends, this gives a curved illusion due to the shadows of their own edges.

The larger letters were hogged out with an electrically driven "Handee Tool" and finished by hand with tools ground from old files and a knitting needle. The style of lettering was stolen from an inscription in England and it isn't orthodox (so says an engineering friend).

The left-hand stone carries a graph of the equation of time for the summer

Figure 5: Stone sundial parts

Figure 6: Rock cabin, sundial

months, also instructions for making the date corrections. By careful interpolation between the 15-minute lines of the dial, and addition or subtraction of date correction, it is always possible to set a watch and find it within two minutes (Sun's "time diameter") of correct time. Help from Mayall and Mayall, "Sundials," is gratefully acknowledged; also from Mayall and Mayall.

This is an east-facing, morning dial and it was built into the masonry over the door of a rock cabin (Figure 6) situated as per the legend carved on the dial: N. Lat. 42°29'40"; W. Long. 76°54'46".

This cabin was begun 15 years ago and has provided a "piece of resistance" for annual two-week vacations. It was placed 4' from the base of the 20' vertical cliff shown (note ladder) and in 18" of water. It therefore is an island. Some 56 cotton cement sacks were filled with mixed cement and aggregates and corded up on the solid rock bottom under water till they reached the surface. Into these, before the concrete set, was thumped the initial course of stone. The 12" wall then was continued to 17' above datum. Approximately 100 tons of 1½" stone selected from the submerged talus by a submerged editor were brought in a rowboat and laid up in concrete mortar. No help was employed on this cabin—it was too much fun.

The flat, five-ply, pitch-and-felt, Barrett Specification roof proved to be the largest and liveliest job of pitch lap making this writer ever did, particularly when the pitch, which was being raised toward 400° F. in an iron washtub over an open fire, flared up in a roar just as both feet became stuck in the hot, soft, just-mopped-on pitch tanglefoot. Has any reader ever found out why two things pick one time to happen?

The castellated design is a perversion of one contributed by Russell Porter. The front porch shown is a temporary eyesore to be replaced by a proper stone stylobate, or basal surround, to give proportion. Porter calls this cabin "Karnac," others refer to it as a mausoleum.

Door hardware was forged from Swedish iron, to a tolerance of 10,000 wavelengths of the B line of sodium light.

Inside are a corner fireplace, Shipmate range, built-in table, a bunk 7' overhead and a stone floor to fall out on.

The "Fisherman Good Luck" invocation relates to the small-mouth black bass that lurk in the foreground in 20' of clear water and chuckle "they'll need it," as the optimists troll past.

This is a vacation hideout, and there's more than one way to hide out on a two-week vacation far from the madding crowd and the razor (Figure 7), while laying stone masonry.

•

¶ *The preceding 53 lines and Figures 5, 6, and 7, give some indication of the excessive mental strain under which Scribe Ingalls has been laboring these past 15 years. The purpose of this note is not only to disclaim all responsibility for the civil-life actions of our associate, and especially for this month's department, but also to warn all "Telescope Nuts" of what may be expected from Scribe Ingalls 15 years from now, when he will have "retired" and be living in his own "mausoleum" (Figure 6.)*—The Other Editors.

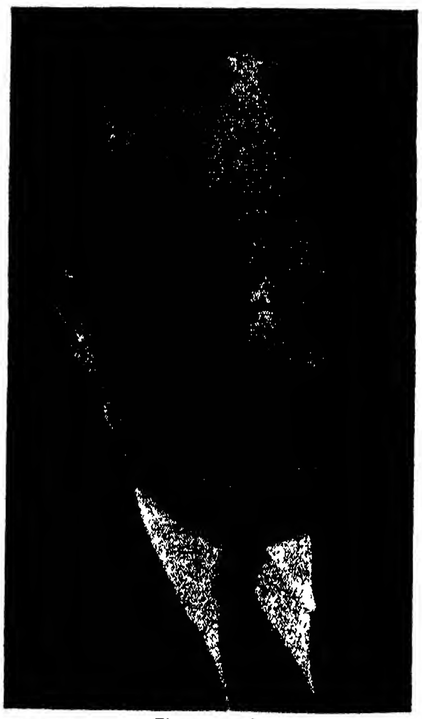


Figure 7: ?

BAMBOO, weightier of Philadelphia's two fine, vigorous gorillas, has a fascinating habit of pitching bananas, tomatoes, and watermelons at some whose looks he doesn't happen to fancy, with such fine control that they learn to keep their distance. His kind of fun. The article on page 246 tells more about him

•

SCIENTIFIC AMERICAN

Owned and published by Munn & Company, Inc., Orson D. Munn, President; I. Sheldon Tilney, Vice-President; John P Davis, Secretary-Treasurer; all at 24 West 40th Street, New York, N. Y.

NINETY-NINTH YEAR — **ORSON D. MUNN, Editor**

JUNE • 1943

SCIENTIFIC AMERICAN, June, 1943. Vol. 168, No. 6. Entered at the New York, New York, Post Office as second class matter June 28, 1879, under the act of March 3, 1879, additional entry at Orange, Connecticut. Published monthly by Munn & Co., Inc., 24 West 40th Street, New York City.

Subscription rate $4.00 per year. Canada and foreign $5.00

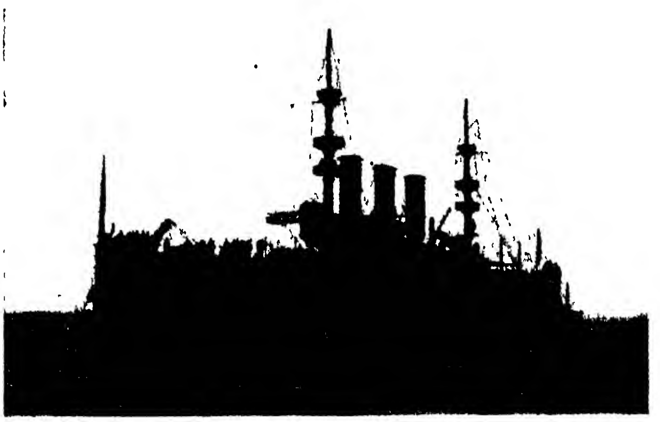
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of June, 1893)

SUBMARINE BLASTING—"The most extensive submarine blasting operation ever undertaken for the improvement of a harbor was that for the removal of the rocks known as Hell Gate, which obstructed the passage between New York Harbor and Long Island Sound. The works for the final operation in removing the middle reef consisted of the excavation of 21,669 feet of galleries through the rock, of an average section of 10 feet square, and involving the removal of 80,232 yards of rock by blasting. The total quantity of roof and pillars remaining to be shattered by the final explosion to a depth of 30 feet amounted to 270,717 cubic yards. The number of cartridges placed in the holes was 42,500, containing 240,399 pounds of an explosive consisting of potassium chlorate and nitrobenzol and 42,331 pounds of dynamite."

CRUISER—"Never before in the history of our navy has the trial trip of a war vessel attracted such general attention as was excited by the final speed test of the new cruiser New York. . . The performance of the engines, boilers, and accessories was excellent . . Not a journal heated unduly nor was any water



used on bearings except as a matter of precaution. . . Her ram bow and high freeboard are conspicuously noticeable as the vessel is seen at anchor, the 8 inch rifles she carries being 25 feet above water. . . She has also twelve four-inch rapid fire guns, eight rapid fire six pounders, four rapid fire one pounders, and four Gatling guns, besides six torpedo tubes, one in the bow, one in the stern, and two on each broadside."

INDUSTRIAL CHEMISTY—"Chemists turn scrap iron into ink, old bones into lucifer matches, the shavings of the blacksmith's shop into Prussian blue, fusel oil into oil of apples and pears, the drainings of cow houses into fashionable perfumery, beggars' rags into new pilot coats, cesspool filth into ammonia, and tar waste into aniline dyes and saccharine."

ENGINES—"The triple expansion engine for ships was first designed by Peter Ferguson (of Fleming & Ferguson, of Paisley), who fitted them on board ship in 1872. To the late Dr. Kirk, however, is due the general adoption of this class of engines, through the clearness with which he demonstrated their superior economy."

LIGHTSHIP WAS ANSWER—"The Lighthouse Board of the Treasury Department has not given up the project of erecting a lighthouse on the outer Diamond Shoal, off Cape Hatteras. The shifting sands of the ocean bottom at this point, combined with the frequency and the violence of storms and the difficulty of getting material to the ground, conspire to make the erection of a lighthouse there more difficult than any undertaking of the kind that has ever been attempted in the world before."

STONE-CUTTING—"French ingenuity has contrived an improved stone-cutting saw of remarkable efficiency—a circular saw having its edge set with black diamonds in the same way as the straight blades; but as the strain on the diamond is all in one direction, the setting can be made much firmer."

ALWAYS ROOM—"We hear so much about the material progress of the age, our wonderful inventions and the great discoveries that are destined to be of untold benefit to man, that it is well sometimes to take a look through the big end of the field glass and see how little really has been accomplished in comparison with what remains to be done For in truth we have but scratched the surface of the globe to a very small extent The north temperate zone alone has begun to be developed, and it is only a beginning—the wastes of Siberia still lying practically uncultivated—while the south temperate zone and the tropics are scarcely touched, with their untold wealth of animal and vegetable products, besides the undoubted mineral resources which they contain. . . The lesson of it all is that there is always room for discovery and that we are nowhere near the exhaustion point of the earth's resources"

PRE-SPARKPLUG—"Ignition tubes for gas engines are now made of a composition consisting of kaolin, chalk, sand, and feldspar. These materials are ground up with water before being mixed, and the coarser particles are allowed to subside, the creamy fluids containing the finer particles in suspension are then mixed and allowed to settle. The paste deposited at the bottom is drained, kneaded, and stored for some months in a damp place. It is then moulded into the required shape, and dried by exposure to the air. The tubes are then packed in cylindrical cases of clay, and heated for fourteen days by the flame of a wood fire. Such tubes have lasted 546 days and showed no signs of wear, whereas a wrought iron tube is often destroyed in three days"

ROADS—"The centralization of power and its distribution by the trolley system have inaugurated a cheap and rapid transportation system for suburban and even rural districts. The country roads have been invaded by the trolley. . . Simultaneously the movement for good roads has mounted into a national issue. All over the country are heard the calls for better roads. . . The ideal road has been claimed to be a Telford or macadam strip with a trolley line on each side. This provides for those who wish to pay fare, while the farmer can transport his product by the old-fashioned way. It is a self-evident fact that horses must become accustomed to the trolley car . . . Already local steam roads have been seriously affected by the competition with trolley roads . . . The next generation will only be able to wonder how its ancestors continued to exist under the regime of slow horse cars."

WOOD PRESERVATIVE—"Naphthalene, which is a product of coal tar distillation, in appearance something like paraffin, has been found useful in England for the preservation of timber."

OUR *Point* OF VIEW

SMALL INDUSTRIES ALSO SHINE

THE IMPORTANT fact that individual initiative is far from dead in these United States is daily being more and more forcefully brought out by charily released information on the progress of war production. First to receive the Army-Navy "E" award among manufacturers were, of course, the larger industrial plants. They were more flexible in operation, had greater resources, could stand momentary losses; therefore, they could more readily convert to war needs. But soon came word that smaller plants were in line for the coveted pennant. They, too, were showing their mettle, were proving that not big business alone could do the things which had to be done to assure victory for the United Nations. And some of them were surprisingly small; at the time of writing, the "E" had just been presented to a six-man plant engaged in precision instrument production This is not the lower limit of size, however. Records show that this plant is the third smallest manufacturing unit to be so recognized for efficiency in service.

That such small plants can do their share, and sometimes more than their share, in the war effort would be accepted as a matter of course if it had not become the fashion, in recent years, to think of American industry as composed of huge corporations with millions in resources at their backs, and with thousands of employees at their beck and call. Not to be forgotten, however, is that these large companies did not spring full-blown from nothing; they, also, had their small beginnings when there was only a tiny shop and the boss worked side by side with employees.

Thus the small plants that today are showing the stuff of which modern American industry is fabricated are but carrying along the traditions of the American way. From the days of metal-worker Paul Revere through the early struggles of Charles Goodyear and the first productions of Thomas Edison to the mighty industrial empires such as that started from scratch by Henry Ford, our nation's history is replete with records of the accomplishments of the "little man."

Now, with World War II setting new industrial production goals, these "little men" are once more proving that they have the guts to fight against odds, to gamble their futures on their faith in their own ability, to give themselves whole-heartedly to the cause that demands the best in every man.

To the small manufacturers as well as the large who have earned the "E" award, our heartiest congratulations. To those who have not as yet reached that peak of perfection goes our faith that they will never let down until the pennant flies above their plants. American industry is in this fight with both fists and both feet. With the shining examples that have been set so far, failure is unthinkable.—*A.P.P.*

ENGINEERING RESEARCH IN UNIVERSITIES

A RECENT plea that industry finance university research in the fields of engineering, uttered by Prof. James Kip Finch of the School of Engineering, Columbia University, brings new attention to one of the aspects of college operations that is all too often forgotten. In the laboratories of these institutions is conducted invaluable research in many fundamentals of science that sometimes comes to public attention in the form of new industrial processes or products. Often, however, the endowment system under which most of this work is carried on is not sufficient to make the greatest possible use of the facilities available.

Thus, states Professor Finch, "the university must turn to industry for the increased support necessary not alone for the maintenance of fundamental research but to make possible that expansion of research activities which will be essential to the maintenance of both industrial as well as educational leadership in the post-war world. . . . While the situation differs in the several branches of engineering it is clear that industry must rely upon our engineering schools not only to train the personnel required in industrial research, but for all possible aid in conducting such research.

"The great bulk of development research," continues Professor Finch, "the search aimed at the development of new or the improvement of older manufacturing methods, at improved quality or lower manufacturing costs, will probably be undertaken by industry. But fundamental research usually has not such immediately practical aims It is true that some of the knowledge that it uncovers often leads to new and patentable products or methods, but much of it is directed toward the clarification and extension of existing theory, and the reduction to a science of hitherto empirical techniques. While development research may thus become increasingly an industrial activity, it seems clear that our engineering college laboratories will continue to share the field of fundamental research with industry."

This makes good sense. Even though the research worker in industry may be as unhampered as possible in his exploration of the unknown, there is always a certain amount of restraint engendered by the knowledge that his work is closely linked with industrial needs Never can he be completely freed from this feeling. In the cloistered laboratories of the university, however, there is less feeling of immediate need, of the necessity for turning up something of practical industrial value that can be put at once into production or other use.

It would seem to us, then, that the plea of Professor Finch is one that should not go unheeded. Properly administered and with adequate safe-guards against exploitation, such co-operative research should have tremendous value to all concerned. Industries that do not, or cannot for one reason or another, maintain their own pure-science research facilities have here an offered opportunity to participate in a branch of work that will be of great value to them in the future and that at the same time will aid in developing our over-all knowledge of the fundamentals. Organizations now doing such work in their own laboratories can benefit by similar co-operation either through an expansion of existing programs or by turning over their fundamental research to a corps of university specialists and concentrating their own resources on applied research

No matter how the details are worked out, the suggestion has great merit and will warrant the fullest investigation and study by all industry—*O.D.M.*

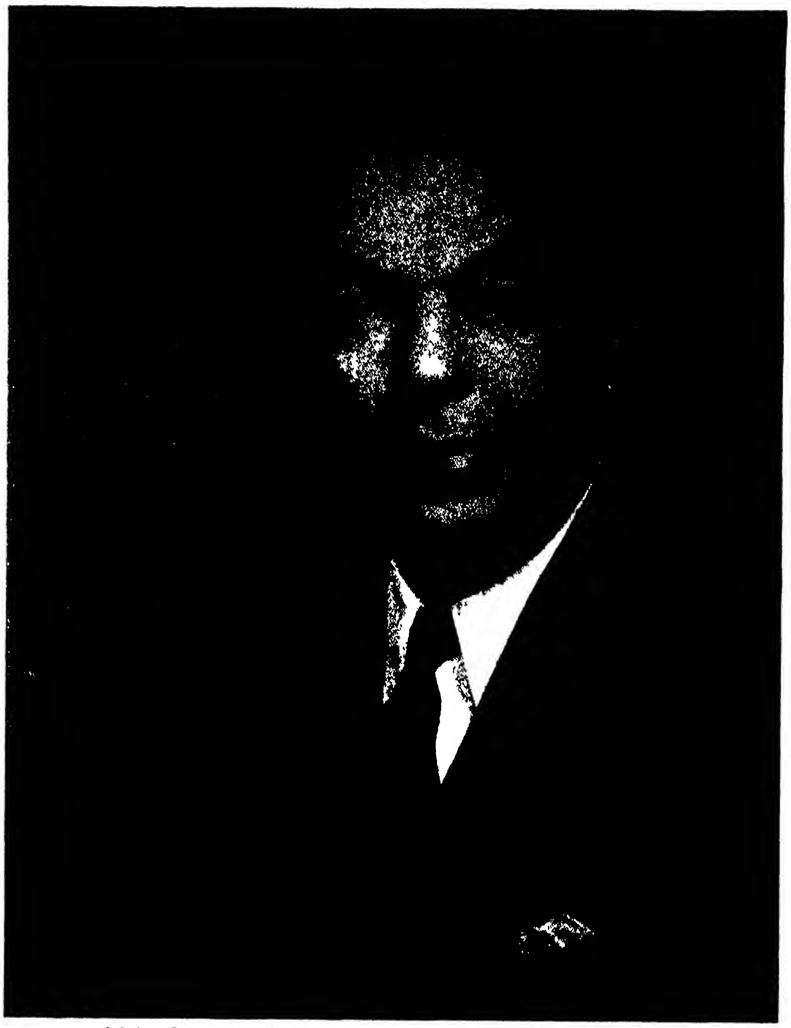
OF MANY TONGUES

MEMORY of school-boy aversions to the study of foreign languages comes clearly to mind when reading of the present educational work which the government is conducting with groups of men who are destined to take over administrative work in many fields when the war is won and the reconstruction period sets in.

Thinking along the same general lines, but apart from the immediate aims of these governmental "schools," those school-boy aversions must by now be sad history for many men. When the war is over and the peace is being won, industries of all kinds will be reaching for foreign markets. There will be a crying need in many fields for technically trained workers who also have a mastery of languages, preferably several. Only those who are equipped with the proper background will find themselves in a position to take advantage of the positions then available.

This self-evident fact makes us urge that fathers guide the thinking of their sons along these lines, that upper high-school and college students take this part of the future into consideration before shying away from languages classes.—*A.D.R., IV.*

Personalities in Science



MAJOR EDWIN HOWARD ARMSTRONG

In the field of radio, the name of Major Edwin Howard Armstrong is second only to that of Marconi. Recently the Edison Medal was presented by the American Institute of Electrical Engineers to Major Armstrong "for distinguished contributions to the art of electric communication, notably the regenerative circuit, the superheterodyne, and frequency modulation." With characteristic modesty, Major Armstrong accepted the Medal with the following words.

"The continuous good fortune that has followed me, providing second chances at inventions when the first chance was missed and tossed away, has been all that a man could hope for and more than he has any right to expect."

Internationally known for inventions which created modern radio and particularly for the invention of wideband frequency modulation, Armstrong is Professor of Electrical Engineering at Columbia University, and likes best the title, "a former pupil of Pupin." Thirty years ago, when Armstrong finished his engineering studies at Columbia, he became the protege of Michael Pupin, Edison Medal winner in 1920.

Armstrong was born in New York City December 18, 1890. While a sophomore at Columbia he became interested in the operating properties of the audion detector, or radio tube. Experimentation at his home in Yonkers, New York, led to his invention of the feedback or regenerative circuit, which increased the sensitivity of the audion hundreds of times as a detector of radio signals. For the first time, useful, solid transoceanic and transcontinental radio signals could be received. The initial Armstrong invention also produced for the first time continuous high-frequency oscillations by means of a thermionic tube.

These giant strides in radio started 18 years of litigation costing millions of dollars. The U. S Supreme Court ruled against Armstrong. Disagreement with the verdict of this tribunal was expressed by the Franklin Institute, the American Institute of Electrical Engineers, and the Institute of Radio Engineers in awarding their highest honors and medals to Professor Armstrong.

The advent of 1917 found Armstrong in France as an army captain, later as a Major, with the United States Signal Corps, in charge of the technical end of Aircraft and Intelligence Radio. While serving in France he perfected his second invention, the superheterodyne circuit, magnifying the weak signals on the short waves thousands of times. This receiving system was greatly superior to any development up to that time, and is still used today in almost all types of radio receivers.

Armstrong's development of the super-regenerative circuit, disclosed in 1922, was his third great invention. The super-regenerative was the means of increasing the sensitivity of the regenerative some thousands of times above that normally obtained by means of simple regeneration, and made possible exploring and developing the short-wave channels, notably for two-way police and military communication systems.

Armstrong secured patents for his wide-band frequency modulation invention, his fourth outstanding contribution to radio and to the world, in 1933. Through "FM." static was conquered, ultra-high-fidelity broadcasting was made practical, and there was opened the heretofore restricted territory of United States radio to the development of more stations and more networks.

Among the honors accorded Major Armstrong are the Doctor of Science Degree from Columbia in 1929 and from Muhlenberg College in 1941; the Medal of Honor of the Institute of Radio Engineers in 1917; the Egleston Medal of Columbia University, 1939; the Holley Medal of the American Society of Mechanical Engineers, 1940; the Franklin Medal of the Franklin Institute, 1941; and the John Scott Medal awarded by the Board of Directors of the City Trusts, City of Philadelphia, 1942. The French government made him a Chevalier de la Legion d'honneur in 1919, and he received one of the 19 national awards of "Modern Pioneer" by the National Association of Manufacturers in 1940.

Major Armstrong may be found at almost any hour of the day in his office or in his laboratory in the Philosophy Building at Columbia. He is neither difficult to find nor hard to see. Rejecting any attributes of genius, Major Armstrong attributes his success in no small measure to "luck, plus a tremendous amount of hard work." His large, well-knit frame bespeaks the outdoor man rather than the laboratory worker. Armstrong's energies these days are now devoted almost entirely to aiding in the war effort—"just like everybody else," in his own words.

99TH YEAR · SCIENTIFIC AMERICAN · JUNE 1943

GORILLA ROUND-UP

Concerning Each of the Sixteen Living Gorillas in these United States

ROGER CONANT
Curator, Philadelphia Zoological Garden

AMERICA didn't become gorilla conscious until a circus bought a specimen called Buddy, rechristened him Gargantua the Great, and ballyhooed him all over the country. Thanks to circus publicity and the fact that, until recently, he was the only portable gorilla in captivity, Gargantua is better known than all other gorillas put together. His popularity is a real tribute to his press agents, for there are no less than 16 gorillas in the United States.

Despite his wide notoriety, Gargantua is not the largest gorilla in captivity, nor the oldest, nor the one which has lived longest outside of the African jungles. Animals now residing in American zoos are the holders of all these records.

Ngagi, who lives in the San Diego Zoo, tips the scales at the incredible weight of 635 pounds, the greatest ever officially recorded for any gorilla. Ngagi, Cincinnati's Susie, and Philadelphia's Bamboo, each estimated to be 17 years of age, all are tied for the honor of being the oldest individuals in captivity. Bamboo also holds the record for longevity; on August fifth, this summer, he will have survived 16 years of civilization.

Gorillas are found only in Africa and two subspecies are recognized, each confined to its own special area. One, the Coast Gorilla, inhabits the hot, tropical rain forest along the Gulf of Guinea, and the other, the Mountain Gorilla, lives 600 miles away in the mountains of the easternmost part of the Belgian Congo.

Between the two beasts, coastal and mountain, there is little to choose. Each attains the same size and the technical distinctions for telling them apart consist chiefly of comparative measurements and anatomical features, points which can be determined with accuracy only after the animal is dead. In general, though, the mountain gorilla has longer, heavier hair and is more showy and desirable for exhibition. When accurate information is available on just where an individual was captured, one can class a specimen immediately, but coastal gorillas also inhabit mountains in certain parts of their range. This leads to confusion and probably more than one so-called mountain gorilla actually belongs to the other race

Determining sex in gorillas is almost as difficult as attempting to classify a specimen of doubtful origin. Males and females look much alike and more than one lamentable mistake has been made Martin and Osa Johnson sold a pair of gorillas to the San Diego Zoo in 1931; now both are known to have been males Massa was delivered to the Philadelphia Zoo as a female, but "she" turned out to be "he." When the circus acquired M'Toto as a mate for Gargantua, the skeptics began shaking their heads, but it is now generally agreed that this animal is a female.

THE anthropoids have a propensity for contracting human diseases and doubtless this weakness, plus faulty dietetics, contributed most to the early lack of success in keeping them at zoos In any event, every gorilla transported from its native habitat died in short order—that is, until recently. Nowadays more is known about keeping them alive and healthy, and there are now no less than 13 of the great beasts in American zoos, plus the two in the circus and one in private hands

Ngagi, the 635-pound champion, is the undisputed leader when it comes to size He lives in the San Diego Zoo and stands five feet, eight inches high in his unstockinged feet. Although well-proportioned, he has the appearance of an obese gentleman who dotes on cake and ice cream and who gets most of his exercise pushing himself away from the table. Briefly and unreservedly, he is immense.

Ngagi and the late Mbongo were captured as youngsters by the Martin Johnsons and both definitely have been identified as mountain gorillas. They were playing together when found and were constant companions until March, 1942, when Mbongo succumbed to San Joaquin disease after a brief illness. They slept and ate their meals in separate quarters but they played and wrestled together every day, although, in keeping with their great weight and dignity, they were not so active and playful in recent years as they used to be. Ngagi is now living alone, but the young female gorilla, Kenya, recently acquired by the San Diego Zoo, someday will be his mate.

Like all gorillas, Ngagi is a vegetarian, consuming 30 pounds of fruit and vegetables daily. Special visitors to the San Diego Zoo are taken behind the scenes at bed time when the big fellow receives his evening meal and is locked in his sleeping quarters for the night Close mesh wire makes it impossible for him to reach out, but it gives visitors a real thrill, none-the-less, to stand inches away from the monstrous animal. With fingers as big around as a woman's wrist, he daintily removes every speck or blemish from his food. He lies down or rests on his elbows while eating and the entire process is one of enjoyment, accompanied by much smacking of lips. Carrots, potatoes, and apples he peels with his teeth carefully and with little waste, the rinds of citrus fruits also are discarded. He prefers his bananas green and bitter, sour grapefruit bothers him not in the least

AN INGENIOUS method of weighing the gorillas was adopted years ago and it is still possible to obtain accurate weights at regular intervals by following the same procedure. A panel, cut in the bottom of the door adjacent to the sleeping quarters, admits the platform of an ordinary warehouse scale. By offering Ngagi food, he can be induced to step upon the platform to be weighed

Chicago has the distinction of exhibiting twice as many gorillas as any other city A fine big male, named Bushman, lives in the Lincoln Park Zoo, and the Chicago Zoological Park, in suburban Brookfield, boasts a male and two females, Sultan, Suzette, and Miss Congo.

Bushman is a burly brute. Like all other gorillas in captivity, he came into human hands as a youngster. Today, standing six feet in height and weighing 473 pounds, he little resembles the tiny mite whom native women nursed when he was captured in the jungles of the French Cameroons.

Upon his arrival in Chicago in 1930, Bushman was very friendly, and the keepers delighted in taking him for romps on the lawn. In their spare time they taught

Reprinted from *Fauna*, published by the Zoological Society of Philadelphia

him to wrestle and to play football. Wrestling came naturally to him, and it didn't take long for him to master the arts of tackling and running with the ball. Had he exhibited anything approaching human intelligence, he might have been in demand for the teams of "dear old Siwash," but unfortunately his brawn grew faster than his brain power. In due time, figuratively speaking, he was putting the keepers' shoulders to the ground far more often than the other way around. One day he caught an attendant off guard. Employing his best wrestling technique, Bushman threw the fellow to the ground with such force that it was indeed lucky he landed on his shoulders rather than on his head. The gorilla stayed in his cage after that and he has not been out of it since, except in 1939, when he was transferred to new and stronger quarters. One of the features of his new home is a huge steel chair on which he sits occasionally. When he does, his weight registers on a dial visible to the public.

Sultan, Suzette, and Miss Congo, the other Chicago gorillas, all are youngsters. They live together in a big cage and, like children, they enjoy playing. A favorite pastime is to jump off a seesaw and let their partner get bumped. The play device they enjoy most is a tub set up under a shower bath, which they operate themselves by pulling a chain. They play pickaback, but Sultan is always the passenger for he is by far the smallest of the trio. The two females, both nine years of age, weigh about 220 pounds each, while he is only seven and weighs about half as much. Miss Congo is the ruler of the roost and she used to give Sultan a drubbing every time they were together. Suzette, with better mother instinct, takes Sultan's part and at the present time, things are progressing amicably.

Cincinnati claims the only educated gorilla in captivity. Surely, Susie's accomplishments merit acclaim, for she sits at a table and eats her meals with her keeper, rings a bell for service, and shows a remarkable aptitude for handling a fork or a spoon. Despite her age and size—she is 17 and weighs 400 pounds—she is remarkably tame and her keeper enters her cage regularly. Because of her docility she is the only living gorilla for which accurate dimensions are available. According to recent measurements, she is five feet tall and her reach, with arms outstretched, is 85 inches from fingertip to fingertip. Her neck measurement is 25 inches, chest 56, waist 64, right arm (around the biceps) 19½, wrist 13, calf 15½, hand (across the knuckles) 7½, foot (heel to toe) 10½. She certainly is no contender for the title of Miss America.

Susie is a coast gorilla and was exported from the Congo to Germany in 1927. Subsequently she was exhibited in Hamburg and Paris. Her trip to America in 1929 was the most unusual ever accorded to any gorilla. Her passage was booked, for $1000, aboard the *Graf Zeppelin,* and she was one of the passengers on the big ship's maiden crossing.

Each of the two gorillas in the Philadelphia Zoo, Bamboo (see front cover photograph) and Massa, has quite an interesting history. Bamboo's point of origin, as is the case with most animals secured from dealers, is rather vague. He had three owners before reaching Philadelphia and most of his early history was lost in the process of changing hands. Quite definitely, he is a coast gorilla.

Philadelphia Zoo's 375-pound Massa, a show-off

Upon his arrival, Bamboo weighed only 11 pounds and he fitted snugly inside the suitcase which served as his traveling compartment. With him, in another suitcase, was a young chimpanzee named Lizzie, who was his playmate for many years and whose constant antics kept him physically fit and on his toes. Since he was the first gorilla to live in America for any length of time, Bamboo attracted wide attention and there is a complete record of his early years and growth.

Eventually, he far outgrew Lizzie and, tiring of her play, he put her in her place. In time it became necessary to remove her, and for awhile Bamboo lived alone and liked it—to judge from all the interest he took in his neighbors. Then, just after Christmas in 1935, Massa arrived. After a period of introduction, which lasted several months and during which the two big animals were permitted first to touch fingers, then hands and arms, they were allowed to enter the same cage together. Massa, although smaller than Bamboo, took the lead at once and for a few days he was king of the cage. Finally Bamboo gave him a clip across the head and orders were issued to separate the two permanently.

Bamboo has an amusing, although unpleasant habit. He delights in throwing things and, after years of practice, he has developed an underhand pitch with marvelous speed and control. Usually he confines himself to throwing handfuls of gravel but occasionally he tosses a banana or a tomato, with disastrous results. A wire fence around his cage helps to protect visitors, but news-photographers, who must go inside the barrier and for whom he appears to entertain a special dislike, are out of luck unless they are adept at dodging. On his last birthday he scored a record by splashing five of them with a single, well-aimed watermelon.

At present Bamboo weighs about 435 pounds, which represents very little change in the past few years. He may now have reached his limit but, judging from the rapid way in which he gains weight if his rations are increased, it is believed that 50 pounds could be added to his bulk in short order, if he were allowed to eat his fill. In the interest of maintaining him in the best of health, such an experiment will not be tried. Bamboo probably preserves more of the dimensions of a wild gorilla than do his more corpulent contemporaries in other zoos—and in the circus.

Massa was raised in a private home in company with Gargantua. As a youth he had the run of the house during daylight hours and great was the mischief into which he managed to get. He delighted in removing the pictures from the walls and enjoyed helping his mistress, Mrs. Gertrude Lintz, of Brooklyn, in scrubbing the floors. It was while engaged in just such an activity that a serious accident occurred. While handling the mop, Mrs. Lintz slipped and accidently struck Massa in the leg. He turned on her and bit her severely. Not long afterward he was offered to the Philadelphia Zoo.

Massa is an inveterate chest thumper. He delights in standing erect for a few moments, meanwhile beating a lively tattoo on his chest with his partly clenched fists. He is a show-off and amuses the

crowds of visitors by dashing around his cage with a flat-footed shuffle. Ripping burlap bags is one of his pastimes. Another is to seize the gymnasium ring mounted on a chain and slam it against the cage bars.

Both Massa and Bamboo have learned to eat meat and they enjoy the fair fraction of a pound of raw hamburg or cooked

Courtesy Zoological Society of San Diego
Mbongo of San Diego Zoo weighed 618 pounds before he recently died

liver which they receive almost daily. Other gorillas also like meat occasionally but, in the main, all are vegetarians.

Massa's exact point of origin is unknown, as is the case with most of the other gorillas, and while he is supposed to be of the mountain type, some doubt has been cast upon this. Perhaps his identity will not be determined with accuracy until after his death, when detailed measurements can be made.

DESPITE predictions that the war would cut off all importations of rare animals, zoo history was made in August, 1941, when no less than eight gorillas arrived in the United States, all at one time. The prime reason for the sudden influx was the relaxation of strict regulations which have, for many years, prevented the mass exportation of the rarer African animals. The newcomers were snapped up like hot cakes and five of them survived. Kenya, of the San Diego Zoo, is one of them; Oka and Makoko, of the Bronx Zoo, and Phil and Mattie, of the St. Louis Zoo, are the others. All are thriving, and already they are taking their places as foremost zoo citizens.

One gorilla, Du-du, imported late in 1942, still is in private hands. Were it not for the fact that several of her eight predecessors did not live, Du-du probably would now be living in a zoo or circus. The uncertainty of war conditions and the possibility that gasoline rationing may decrease attendance, and thus lessen income, have made zoo officials a bit chary about acquiring another expensive specimen. Du-du is an infant, as great apes go, being only three years of age, but the chances are that before many months have passed she, too, will be on public exhibition somewhere in a zoo or circus.

Both of the two remaining gorillas in the United States belong to "The Greatest Show on Earth." Care, comfort, and publicity have been lavished upon them and there are few persons who do not know at least something about them. They travel in air-conditioned cages and are sonorously and extravagantly billed as "Mr. and Mrs. Gargantua," and, without a doubt, are the greatest attraction in the entire Ringling Circus. Both were raised in the lap of luxury.

Gargantua, who started life as Buddy, lived in Brooklyn with Mrs. Lintz and Massa. On shipboard en route to America, he suffered severe acid burns on his face and chest, resulting in scars which help a great deal in his billing by the circus as "The World's Most Terrifying Creature." Several times he has managed to lay hands upon circus employees, never with fatal results, but his cage has been rebuilt to prevent future accidents. He is a big fellow and, while competent judges won't admit that he weighs as much as is claimed for him—well in excess of 500 pounds—he is a splendid specimen and, like most circus animals, in the pink of condition. Getting him to do his keeper's bidding is well-nigh impossible, but he still can be jockeyed into a small compartment at the end of his cage by showing him a snake. Like many other primates, he has a distinct dislike for serpents and he gets as far away from them as possible.

Mrs. Gargantua, nee M'Toto, is a wife in name only. As yet she has not been near her intended spouse, except to look at him through the bars of her cage and throw back the garbage which he tosses at her. The circus people say that it will be a year before they will risk allowing the two together.

M'TOTO is the most roly-poly gorilla imaginable. She is as broad as she is long and could give the circus fat lady a run for her money. Accustomed to being waited upon since infancy, she will accept only such foods as she chooses. These are cooked especially for her and her menu includes a long list of custards and purees. She was raised by Mrs. E. Kenneth Hoyt, who took her to Cuba when a child specialist in Paris advised a more equable climate for the then young gorilla. M'Toto had the run of the Hoyt estate for a time, and Mrs. Hoyt and the keeper can do almost anything with her.

And that completes the roster. Every one of the 16 is a champion in its own right, at least in the eyes of its owners. Each appears to be in the best of health and destined to live for years to come.

Everyone hopes that they will, for the time may come, and not too far distant, when gorillas may be a thing of the past Already they are rare and the relaxation of the laws protecting them, resulting from the present chaotic conditions, has permitted raids upon their numbers which would not have been tolerated under normal circumstances. Several years ago most of the European nations with colonies in the Dark Continent agreed to prohibit the exportation of many rare African animals, including the gorilla.

Possibly within the next few decades the only gorillas remaining alive will be the few which survive in zoos. More than one spectacular mammal has succumbed to the inexorable advance of "civilization."

NAME	Sex	Weight	Year of Arrival	Estimated Age
BAMBOO Philadelphia Zoo	Male	435	1927	17
BUSHMAN Lincoln Park Zoo	Male	515	1930	15
DU-DU Private Owner	Female	37	1942	3
GARGANTUA Circus	Male	550	1937	13
KENYA San Diego Zoo	Female	150	1941	8
MAKOKO New York Zoological Park	Male	64	1941	5
MASSA Philadelphia Zoo	Male	375	1935	13
MATTIE St. Louis Zoological Park	Female	140	1941	6
MISS CONGO Chicago Zoological Park	Female	220	1936	9
M'TOTO Circus	Female	400	1941	12
NGAGI San Diego Zoo	Male	635	1931	17
OKA New York Zoological Park	Female	48	1941	3
PHIL St. Louis Zoological Park	Male	50	1941	4
SULTAN Chicago Zoological Park	Male	120	1937	7
SUSIE Cincinnati Zoo	Female	400	1931	17
SUZETTE Chicago Zoological Park	Female	220	1936	9

The 16 living gorillas in the United States

Where War Surprises Are Born

New Weapons and Standardized Maintenance Methods Are Developed at a Center in the United States

MERRILL FOLSOM

Now that the M7, the surprise weapon that first sent Marshal Rommel reeling on the African front, has seen the smoke of battle and is no longer held secret from the enemy, the evolution of this now famous tank killer and fortress blaster can be related.

It is an evolution sired by the changing demands of modern battle and nurtured by American manufacturing ingenuity; it is typical of the life stories of many new weapons, still clothed in military secrecy, that are flowing from our factories to armies of all the Allies.

When Rommel caught British forces by surprise on the Libyan desert in the Autumn of 1941 by suddenly using 88-mm cannon to shatter tanks and blast vital gun-emplacements, the news was flashed by U. S. observers to Army G-2 headquarters in Washington. The Nazi cannon were not self-propelled, but their firepower was so superior that the elephantine battle-wagons of the British often were left a shambles or sent scurrying for cover.

Having long been aware that keeping a jump ahead of the Nazis in the development of better armaments was like playing leapfrog, Army engineers here were already working on a new weapon which consisted of the powerful 105-mm howitzer mounted on the highly mobile M3 medium tank chassis.

The contrivance resulting from this marriage became known as the M7, a self-propelled weapon never before equalled in the world. It was capable of shattering objectives at distances of seven miles and then speeding at more than 35 miles an hour to new places of vantage before dive bombers could locate it and shower missiles from the sky.

The M7 appealed to officers of the Army Ground Forces and Ordnance Department as the ideal answer to the Rommel 88's, so it was labeled a "hot project" for immediate action. In 16 days final layouts for production models were drafted, and three weeks later the first M7's were delivered at the Aberdeen Proving Ground in Maryland for testing.

Part of the genius behind the development of the M7 was the fact that it was made of component parts which had hitherto been tested and standardized for other armaments, so after only minor revisions in machine guns and armor the new weapons were soon going secretly overseas in quantity.

Before the end of 1942 they were hitting Rommel hard on all the African fronts, serving as tank killers by firing armor piercing shells and as the Nemesis of the 88's by firing high-explosive shells—all the time jockeying for position in a manner well beyond the capabilities of the immobile Nazi howitzers.

Development work of the type which resulted in the M7 is conducted by the War Department's recently activated Tank-Automotive Center in Detroit. If a new variety of tank is needed for invasion of Europe, a lighter gun mount for traversing swamps of the Solomons, or a revised armored car for reaching mountain fastnesses of Burma, the job of designing and producing the conveyors of cyanide devolves upon the TAC. With so many of the Allies relying on us for war machinery, the job has become colossal. The production of Ordnance materiel has risen 71,000 percent in 30 months; present contracts at the TAC total $25,000,000,000.

In the program are many surprises for Hitler, Hirohito, and Mussolini. One mentioned by Major Gen. Levin H. Campbell, Jr, Chief of Ordnance, is a 240-mm. howitzer capable of shooting a 350-pound TNT shell with sufficient accuracy "to lay it right on the city hall steps."

The TAC is a slice of the War Department, lifted from the congested banks of the Potomac and placed in the center of the automotive industry of Michigan. It is a concentration of 99 percent of all the tank and automotive work of the Ordnance Department, and serving at its headquarters are numerous liaison officers of the British, Russians, Chinese, and other Allies who get American mechanized legs to speed their fighting armies.

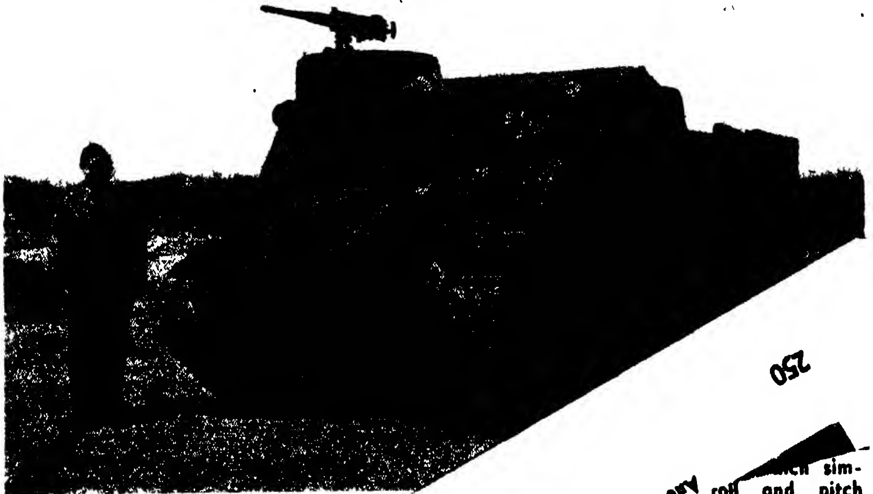
Work of the TAC spans the world. In addition to keeping in constant communication with task forces across the seven seas, it tests its tanks and vehicles in the heat and sand of California, on the beaches of Florida and Maine, in the snows and rocks of Colorado, on the blizzard-swept plateaus of Manitoba, and at the wide expanse of Aberdeen.

The modern and balanced team of vehicles handled by the TAC includes items ranging from 60-ton tanks to featherweight military bicycles. On the list are complete assortments of light, medium and heavy tanks, reconnaissance vehicles, jeeps, amphibians, scout cars, gyro-stabilized tank guns, command cars, self-propelled artillery and anti-aircraft weapons, cargo vehicles, personnel carriers, and motor transport vehicles. In all, there are more than 200 varieties of tanks and wheeled vehicles.

Not the least of the TAC's problems is that of standardization and simplification of vehicles—a subject that sounds minor and until the war became global failed to make much impression on some Army officers. But with the war now conducted on far-flung battlefronts, requiring supply and repair depots at every scene of operation, standardization of parts has become a problem of first magnitude.

At one time the primary aim was to get serviceable vehicles into action as swiftly as possible, regardless of how much uniformity of design existed. Quantitatively this was a good job, but the result was that so many varieties of vehicles were reaching war zones to perform the same type of service that the maintenance problem became unnecessarily acute.

Every tank or truck with a different type of engine, axle, transmission, wheel bearing, or chassis needed different spare parts and tools, as well as specially trained maintenance crews. An average tank has 30,000 parts and 200 special tools. Multiplying these figures by the number of variations in component parts — parts which could often be identical—carried



The M7 tank destroy

the maintenance problem into astronomical digits and left many supply depots issuing cries of anguish instead of spare parts.

After serving eight months on African deserts, Lieut. Col. Joseph M. Colby, chief of the TAC's Development Branch, returned to this country and remarked:

"Our greatest thrill in Egypt came at a time when we received a set of major overhaul tools for the Continental engine. Our greatest disappointment occurred when we opened that package and found that this lovely set of American tools was for the Guiberson Diesel engine. We had no Guiberson Diesel engines in Egypt.

"The greatest improvement which we can now make in simplifying our maintenance problem is the simplification of the equipment to be maintained. In a theater of operations we can train men to take care of one engine and we can furnish tools and spare parts for one engine, but if this one type of engine is increased to three or four different types, it means that the burden of each of the essential elements of maintenance—trained men, spare parts, tools, and facilities—is increased in direct proportion to the number of different items to be maintained."

An early step in the standardization move was to establish a simplification section in the TAC, with Lieut. Col. Frank A. Mickle, former associate professor of mechanical engineering at the University of Michigan, heading the group. Standardization of the tank engine was one of the first objectives, and one engine soon was chosen for mass production.

The TAC has five branches, Development being the first to deal with a new vehicle. The next is Engineering, which determines the serviceability and maintainability of new types of equipment. Then come Manufacturing, charged with having vehicles produced by private manufacturers and arsenals from coast to coast; Supply, which must have the finished materiel delivered to task forces throughout the world in proper quantities and at proper moments; and Maintenance, charged with the enormous job of keeping rolling stock rolling.

Detroit was already teeming with activity when the TAC arrived in town, and to secure office quarters it was necessary for the War Department to lease the Union Guardian Building, a 40-story downtown office structure then occupied by 160 private tenants. But this space was not enough, so several floors in the near-by Buhl Building and in the Fisher Building uptown were also taken.

To house some of the 400 Army officers and 3600 civilians who came from every state to work at the TAC, the government obtained 500 rooms in hotels such as the Book-Cadillac, Statler, and Fort Shelby, paying half the rent and allowing the workers to occupy the rooms for ten or fifteen days by paying the other half. At the end of that period the workers had to find permanent lodgings, and to ease the rent burden the TAC obtained occupancy priorities on apartments in several low-cost housing developments.

In line with its policy of assigning to industry as large a role as possible in the conduct of the war, the Army installed Brig. Gen. Alfred R. Glancy as Deputy Chief of Ordnance in charge of the TAC. He is an old-time automobile manufacturer, having been president of the Pontiac Motor Car Company and a vice president of General Motors, and he was partly responsible for the industrial success of southern Michigan.

No stickler for military formalities, and thoroughly irked by duplications of effort in some government offices, General Glancy is running the TAC as he would an automobile company. His aides may have high military rank, but in the armament production cycle they are just hired hands. Task forces are his clients. And the shortest distance for him between two points is a straight line, bypassing organizational flubdubbery and bureaucratic protocol by a method which he whimsically calls "Mrs. Glancy's treatment."

The general shuns armed guards. A badge system of identification for his civilian workers, designed by old-time Army officers after the fashion of a system used to protect offices in Washington, was short lived when General Glancy began his corner-cutting. He can get much more excited over a discovery that one type of grease can be used in a tank which hitherto required five types than he can over a discovery by some highly-schooled officer that secret documents are being stamped with green ink instead of specified red ink. This attitude mystifies some Army men.

His desire for efficiency ahead of protocol is catching. When a school for mechanics in one of the Ford factories needed five engines for study—engines which were rolling off an assembly line a few hundred feet away—Army regulations required that the engines be shipped first to the Rock Island Arsenal, from which the school could requisition them. The Glancy treatment was used by aides, however, and the five engines were rolled across the floor to the school, leaving the formalities for some one else to worry about when inventories are taken.

These shortcuts occasionally lead to confusion. The librarian of the TAC was moved 19 times during the "shaking down" process in the Union Guardian Building, and then one Saturday afternoon General Glancy decided there was no need for the library anyway. In 20 minutes books and pamphlets were torn from the shelves, ending three months of work. But on the following Monday morning the general was convinced that the library had some value and should be restored. William Schild, the librarian, put things back in shape. Not long afterward, however, he was moved the twentieth time and decided to leave the TAC and return to his former job as sales manager of a Chicago paper company.

Brig. Gen. John K. Christmas, long an authority on tanks, is Deputy Chief of the TAC, and the general staff includes a mixture of men whose fighting experience goes back to 1917 and others who have just stepped from executive offices of the large automobile companies into uniforms of captains, majors, and lieutenant colonels—and higher.

Among these new officers are Lieut Col Benjamin Ourisman, who had one of the largest automobile agencies in the world; Colonel Graeme K. Howard, former vice president and overseas manager for General Motors, and Lieut. Col. Felix Doran Jr., former manager of the Fleet Division of General Motors. In addition, General Glancy brought to his civilian staff such men as Lee Anderson, long a kingpin in the advertising work of General Motors, Chrysler, Hupp Motors, and Packard.

Typical of the experienced Army men who are being shoved to the top in the TAC is Colonel Colby. Thirty-eight years old and of almost boyish appearance, he was graduated from West Point in 1929, served in the air corps and cavalry and then went to work in earnest on tank design. In 1933 he helped perfect the first modern tank, known as combat car T4, which had the first radial aircraft engine used in a tank, rubber jointed tracks, and a controlled differential that permitted smooth steering. Compared with the 4 to 8 mile-an-hour speed of the World War tanks, the T4 could travel 55 miles an hour on wheels and 37 on tracks.

Another tank destroyer, mounted on a Half-Trac chassis

Colonel Colby's wrath rises when he hears of Army men who believe the tank is the only important vehicle in modern battle and that heavy artillery should still be pulled muzzle backward by separate tractors instead of being mounted on tank chassis. From his experience as a boxing champion at West Point and as a cavalryman in the field, Colonel Colby gained firm convictions that maneuverability and unification of all offensive forces is imperative.

"The principles of war do not change," he said. "After my observations of operations in the Middle East and after having closely studied German moves in the lowlands, France, Poland, Czechoslovakia, Norway, and Russia, I am convinced that the principles of war have not changed since the day Alexander rode at the head of his heavily armed cavalry.

"Security, reconnaissance, mass movement, and reserve hold their same importance. The only thing that is new in this war is speed. The tank has entered the battlefield and has changed the pace from that of the foot soldier to that of the mechanized vehicle.

"The backfield men of a football team are its most spectacular players They get all the publicity and, therefore, there is a common tendency among most young people to want to be quarterbacks, halfbacks, and fullbacks. But any one who has played the game knows that the success of the quarterback is based on the efficient functioning of the ends, the tackles, the guards, and the centers, and their coördinated operations as a team

"Because the tank has been the pacesetter of this highly mobilized war, publicity has been centered on the tank, with little publicity given to the other members of the combat team which enable the tank to become effective. If a quarterback is able to run faster, it is essential to give him fast interference. Because the tank has increased the pace of the battlefield, it is essential that the speed of the other elements of the combat team—reconnaissance, communication, support artillery, and others—be likewise increased"

Co-operating with the TAC are numerous civilian and governmental agencies. The Industry Integration Committees, composed of leading industrialists, handle specific problems such as allocation of alloy steels, tools, dies, armor plate, and tank tracks. They keep industry operating like one large family, pooling resources and headaches; they enable manufacturers to deal directly with one another, swapping parts, raw materials, machine tools, and improved methods of operation.

The United States Tank Engine Committee, with the heads of the larger automobile companies as members, is performing a difficult job on tank engine improvement, standardization, and production.

When Colonel Colby returned from Africa and reported that Rommel's early successes had been due to his emphasis on maintenance, using 20 percent of his entire army on repair work and being able even to restore broken tanks to service while battles were raging, new emphasis was placed in Detroit on schooling for United States maintenance men.

Tractor-drawn heavy cannon, ready for rough cross-country travel

The TAC consequently is collaborating now with the Military Training Division of Ordnance in promoting 13 large schools for the training of ordnance soldiers in the repair and maintenance of tanks and wheeled vehicles. Here, again, industry has been put to work. The schools are operated in automobile factories, with the companies furnishing all equipment as well as the teaching staff.

"Got to be damned sure no boy's ghost will ever say, 'If your training program had only done its job,'" is the slogan emblazoned on walls of these schools

Bakers, lingerie salesmen, jewelers, pretzel makers, gasoline dealers, and grocery clerks are among the students who are learning, with a few weeks training, to repair everything from a gyrostabilizer to a 3000-pound tank track On completion of the course of study they are sent to Africa, Europe, Asia, and Australia to keep the Army's machinery running

• • •

DECKING MATERIAL
Has Many Military and Industrial Uses

Especially adapted to war and cargo ships, a new lightweight decking material with myriad potential applications was announced recently by the Goodyear Tire & Rubber Company. O. C. Pahline, manager of the company's flooring department, said the new material is known as "Dektred"

Easily-applied and long-wearing, "Dektred" can be used on metal, wood, concrete, and many other types of services where tests have shown exceptional serviceability. Under government and Goodyear auspices, "Dektred" has been tested in temperatures ranging from 50 degrees below zero to 160 degrees above zero, Fahrenheit. These tests showed, Pahline disclosed, that "Dektred" is unimpaired by cold It may soften slightly in high temperatures, he said, but returns to normal when temperatures are lowered. In other tests "Dektred" was described as completely resistant to the action of oils, greases, gasoline, salt, sulfur, and cleansing detergents such as soap.

It is produced in a thick liquid and is applied by spraying or with steel trowel. As it is self-levelling, repairs can be made with no appearance of patchwork, it is claimed.

"SEA-SICKNESS" MACHINE
Puts Equipment Through Severe Paces

In order to test various types of naval equipment and to make sure in advance that it will be able to withstand all the ups and downs of a warship ploughing through the high seas, a Scorsby testing device has been installed at a plant of the General Electric Company.

One of our photographs shows this machine in use, with a development engineer risking sea-sickness by riding with equipment under test.

Mechanical "wave-maker," which simulates the ocean's roll and pitch

Helium arc welding equipment, with swinging overhead cable and hose support

Helium Aids in Welding

Method Requiring No Flux Gives Many Advantages in Welding Magnesium, Important in Aircraft Fabrication

S. R. WINTERS

Like a two-edged sword, helium—the non-inflammable light-weight gas, of which the United States has a virtual monopoly—is now able to function in the two-fold role of buoying up submarine-spotting blimps and of speeding the production of war-planes. The first-named use is according to normal practice; whereas it is novel procedure to employ helium in a welding process in the manufacture of aircraft.

A new welding torch and a method developed by engineers of the Northrop Aircraft, Inc., make possible the new process of helium welding. Somebody has said that success in life is the triumphant embodiment of many little things; similarly, some of our large airplanes involve the use of hundreds of thousands of tiny rivets. Hence the customary riveting procedure has been cumbersome and time-consuming.

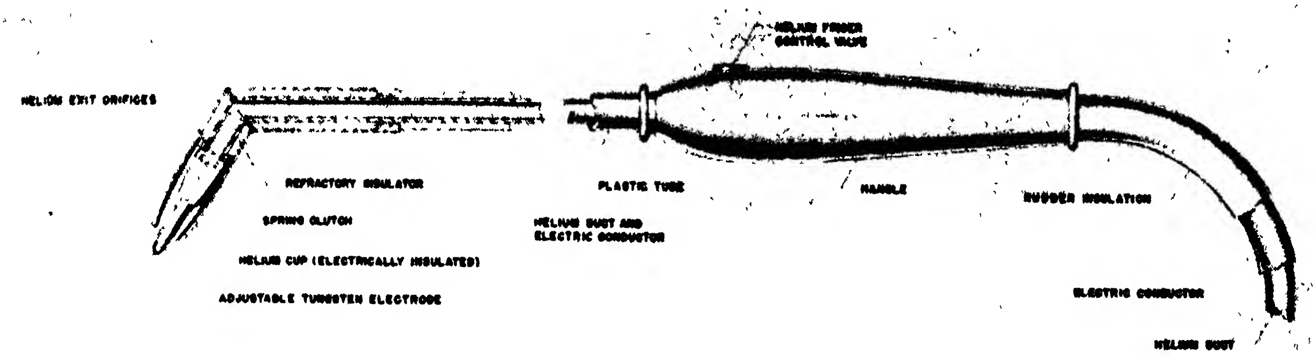
The helium welding process renders possible and practical the fusion of inflammable metals, such as magnesium; the latter, owing to its extreme lightness, is being employed increasingly in airplane construction. When utilized in the shape of sheets, as in the covering for wings, fuselage, and other parts of the flying machine, magnesium has heretofore ordinarily been gas-welded, but now may be "Heliarc" welded with no danger of entrapping flux (as in gas welding) because none is used, except that supplied by the action of the helium. Furthermore, the use of flux promotes corrosion, which makes for hazardous conditions on magnesium.

When magnesium is blanketed with a covering of a monatomic inert gas, such as helium, it will not ignite. Also, according to welding authorities, magnesium and various alloys thereof, such as, for example, the different grades of "Dowmetal," rapidly lose their stiffness upon being heated at relatively high temperatures. The new weld produced with the helium blanket, however, is said to be about equal in strength to the magnesium metal itself. Under service conditions, it has been determined that in the welding of magnesium the cast-structure of the weld has about 85 percent of the strength of the originally wrought metal, in pounds per square inch. Since this new welding-torch process affords the means of making a magnesium weld wherein the area of the weld section may be increased approximately 100 percent over that obtainable by other methods, the weld portion is stronger than the adjacent material.

To obtain the protective blanket of helium, the inventors of the process have designed a special electric torch having a hollow handle and nozzle through which the non-inflammable gas can be passed. The helium valve of the Northrop Heliarc welding torch is opened just before striking of the arc between the tungsten electrode and the parent metal Helium has more than five times the specific heat of air and when in motion forestalls the amassing of heat around the weld. Thus the welding process is surrounded by relatively cool atmosphere, affording a better fusion and penetration with less distortion than obtained in other welding processes.

A sort of hit-and-run procedure, the arc is struck by a light brushing action and immediately drawn away from the metal. The "Heliarc" torch tips, soon to be available to the whole aircraft industry, are of three sizes, held at different angles of 40, 60, and 90 degrees. The new torch may be employed for pencil welding or, by means of a longer handle bar, a grip is available for heavy welding Another design of this torch, yet to be made available for the industry, is one that feeds the filler rod automatically, which is said to afford more uniform results than when the present hand-fed rods are used.

The general set-up for producing a butt-weld includes a pair of magnesium sheets which are held securely in a jig, the edges to be welded being scarfed. The angle formed by the latter is about 90 degrees, this varying somewhat with the thickness and specific chemical structure of the magnesium or alloys being welded. The lower edges of the scarfs are closely adjacent, and the sheets are usually positioned in a horizontal plane, so that down-hand welding may be used, but there is no trouble in welding vertically or overhead. Just beneath the scarfed edges of the sheet is stationed a backing plate, ordinarily of steel and having a central semi-elliptical channel thereon, centered with regard to the aligned edges of the scarfs. The backing plate may, logically, be an integral part of the jig. For best results, the chilling effect of the backing plates on the weld can be reduced by suitable heat-transfer means, preferably electric, embedded in



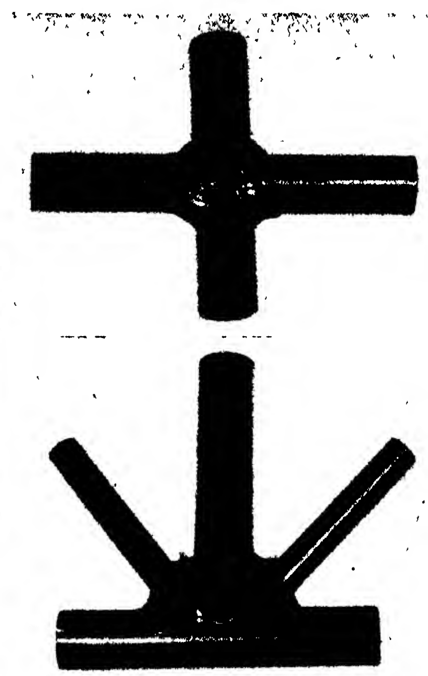
Sectional drawing of one type of Heliarc welding torch, with electric conductor and helium duct in one covering

the backing plate. On small jigs, heating with a gas torch is satisfactory.

In this process of fabricating aircraft parts from magnesium, the most satisfactory results are obtainable by feeding the filler rod into the molten pool at the edge of the arc. Inasmuch as the radiated heat from the arc heats the filler rod excessively, an angle of 60 to 90 degrees must be kept between the rod and the electrode The latter varies in size from 1/16 of an inch to 1/4 of an inch, depending upon the thickness of the metal being welded and the heat necessary The torch is held as near the weld as possible to insure the greatest effect from the helium as a preventer of oxidation and as a conductor of heat. Also, a short arc is desirable for best results, since gas holes or poor penetration may result from using too long an arc.

The usual arc-welding machine, with a direct-current generator having a 150-ampere output, is preferable. Higher output machines, functioning at less than 300 amperes, may be employed if lower amperage ranges are obtainable. Obviously, an upright welding machine is desirable, so that a helium tank may be readily attached to it. Separate amperage and voltage regulators are not necessary but are helpful and these devices preferably

This broken Heliarc welded magnesium test specimen shows that the weld is stronger than adjacent parent metal



Two types of Heliarc welds produced in joining Dowmetal-J tubes with wall thicknesses of .040 of an inch

Heliarc welding, illustrating use of back-up strip and angle of filler rod

should have a continuous sequence of five increments of current control. A 200-cubic-foot helium tank will, on the average, do 35 hours of continuous welding with a medium-sized torch. Commercially pure helium is required.

If the magnesium sheets vary in thickness from .040 to .10 of an inch, an open-circuit generator voltage of from 40 to 60 volts is suitable, the amperage varying from 35 to 75 amperes, in accordance with the demands of the job. Helium is then permitted to flow at low pressure—¾ of a pound per square inch—through the nozzle to emerge from the open end around the tip of the tungsten rod. Then the arc is struck against the object to be welded and, as previously mentioned, the magnesium-alloy filler rod is fed into the edge of the pool rather than into the scarf. The arc is moved to the bottom of the latter, then to the top of the bead, as the metal from the filler-rod is melted in the arc. This procedure insures complete fusion of the metal, the arc being maintained close to the puddle formed by the metal melting from the filler-rod and the sheet edges. According to the inventors, the cold filler-rod should never touch the

tungsten electrode and should not be used to form the puddle by an inexperienced welder; to do so will produce an undesirable gas pocket. The filler-rod is used simply to feed metal into the arc. The puddle is then formed by movement of the tungsten electrode, with the weld metal being directed in a flow from the side from the filler-rod. If these desired conditions prevail, the tungsten does not make deposits in the weld, but is transformed to tungsten oxide, and either vanishes as a gas or makes deposits on the magnesium sheets as magnesium tungstic oxide—a dust scale which may be brushed off later. As a further contribution to more perfect welding, the end of the welding torch is so designed as to prevent oxygen from being drawn into the arc area by action of the outflowing helium.

It is a comforting thought to envision the speeding up of fabrication in an airplane factory in California as having a vital relationship to an offensive by Soviet Russia; to a sweep of English or American bombing planes over German-occupied coastal cities or thousands of feet above the burning sands of the North African dessert. In this global war the successful welding of magnesium parts for airplanes in California is one of the links that will forge a weapon for the defeat of the aggressor nations, wherever their ugly and venomous heads may rear themselves

• • •

CORKS

"Cow Apple" Roots May

Be Source of Substitute

Tests have been carried out in Jamaica with a view to using a locally grown plant as a substitute material for cork, say recent trade reports.

This new product has been developed from the roots of a swamp plant known in Jamaica as "cow apple." The botanical name of this plant, which is found in large quantities in the swampy areas around the island, is *Annona palustris.*

Corks from this root have been made experimentally by one Jamaican firm. It is stated that they are not satisfactory for corking bottles of rum, but could probably be used for vinegar and similar liquid products.—*The Chemurgic Digest.*

INDUSTRIAL ANALYSIS

Speeded by Use of

Mass Spectrometer

In a closely guarded laboratory in the heart of a Philadelphia oil refinery, physicists have achieved a new triumph in the application of electronics to the war effort. The achievement is the industrial use of the mass spectrometer. The research organizations of The Atlantic Refining Company, and of the Consolidated Engineering Corporation have co-operated to bring this device to practical use in a manner which will expedite the manufacture of aviation gasoline.

This development makes possible a marked improvement in the analysis of gases which are used in making high-octane aviation gasoline and synthetic rubber stocks, and opens the door to unlimited research in these fields. In addition to improving present production methods, it is expected that the mass spec-

Accelerated manufacture of gasoline and synthetic rubber is anticipated

trometer may pave the way for entirely new gasolines.

The use of the mass spectrometer permits analysis of some gases that cannot be separated by distillation procedure. Such extension of the ability to determine hydrocarbons in gasoline may lead to the development of better, or even new gasolines The new method is eight times as rapid as the old, resulting in closer control of plant operations, because rapid analysis of samples permits much more frequent testing and checking of plant equipment.

Because of its importance to war production, the instrument is now being operated under a policy which limits disclosure of its results to those engaged in the national effort to manufacture greatly increased quantities of high-grade aviation fuels, and details of construction and operation are blanketed under secrecy orders. Weighing slightly more than two tons, and small enough to fit into an ordinary-sized kitchen, the mass spectrometer looks like a high-powered radio transmitter.

INVISIBLE "RAINCOAT"

New Chemical Waterproofs

Many Kinds of Materials

An invisible "raincoat" which can be formed on cloth, paper, and many other materials by exposing them to chemical vapors, thereby making them water-repellent, has been developed in one of the General Electric Research Laboratories, Dr. William D. Coolidge, Director of Research, has announced. Many possible uses of this new method of waterproofing are now being studied. One of the most important so far is the treatment of ceramic insulators for radio equipment used by the armed forces of the United States.

Such insulators lose much of their electrical resistance when exposed to high humidity. This causes formation of a thin film of moisture on their surfaces and allows the currents to leak away. It has been the practice to coat them with wax, but the new chemical treatment is about nine times as effective, and its results are permanent.

The process was discovered by Dr. Winton I. Patnode, research chemist. Various chemicals are used, one class being known as methyl chlor silanes. In a closed cabinet, the articles to be treated are exposed for a few minutes to vapors from such a compound. Then they are taken out and, if necessary, are exposed to ammonia vapor. This is to neutralize corrosive acids which may collect during treatment.

Dr. Patnode is not able to explain exactly what happens in the process, but the result is that an extremely thin film, which resists wetting, is formed on the surface. This "raincoat" is so thin that its structure cannot be determined by chemical analysis. It cannot be seen under a high-powered microscope. But, whatever its nature, it prevents water from spreading to form a continuous film. If moisture does collect, it is in the form of small isolated drops. In the case of the ceramic insulators, these do not allow electricity to pass because they are separated from each other.

The treating liquid vaporizes at a temperature below the boiling point of water. However, the water-repellent film is not volatile, but remains permanently. It is not affected by temperatures as high as 550 degrees, Fahrenheit, applied for short intervals, nor by cleaning fluids such as carbon tetrachloride, naphtha, or gasoline. It is only mildly affected by continuous exposure to sun and rain.

PLASTIC FORMS

Rival Steel in Toughness,

Are Much Lighter

A plastic which, it is predicted, will increase airplane production by 50 percent, has been developed in the chemical engineering laboratories of Columbia University, in co-operation with plastic manufacturers and plane producers. The material will be used in making forming blocks, dies, and jigs upon which the metal parts of airplanes are fabricated. It has been found far superior to the present-day materials used for the same purpose such as wood, steel, and various alloys. The tough characteristics of the plastic, such as high impact strength, hardness, low compressibility and durability, make it rival steel in many respects, but with only one-fifth of its weight.

This new plastic, known as Thermo-Cast, possesses the unique property which permits it to be melted and cast into shapes without the use of pressure somewhat the same as metal, but at much lower temperatures and with more exactness of mold dimensions.

It is still pretty much of a "new born baby" with a future beyond present-day imaginations. In place of the present airplane composed of small sections of

metal pieces held with literally thousands of rivets and requiring many more thousands of holes to be drilled, and the rivets offering sufficient wind resistance to reduce the speed of our airplanes by as much as 10 to 15 percent, the airplane of tomorrow may be made in large sections, stamped out as a whole on plastic forms and with the use of plastic punches.

Resembling red sealing wax, the product is described as a thermo-plastic material which is readily reduced to a molten state by heating to 200 degrees, Centigrade. The melt can be easily poured into simple molds, in the same manner that metal castings are made, in order to transform the plastic into the desirable shapes for the metal working operations.

ELECTRONIC FUTURE
Is Seen as Bright in
Many Industries

THERE ARE vast untapped potentialities in the use of electron tubes in research and industry as well as in communications, according to the current issue of *Electronics* magazine Over the past few years, it is stated, light beams employed in conjunction with photo-electric relays have enjoyed an increased usefulness in industry. In a similar way, ultra-high-frequency beams may well find some applications along the lines of photo-electric relays but applied where light will not function due to the fact that it will not go through certain materials or will not readily carry a sufficient distance. There are many possibilities in the use of television principles for industry. Routine clerical details attending such simple procedures as a purchase in a department store, the buying of a railroad ticket, the sorting and distribution of mail, and payroll accounting as well as a host of other clerical operations, will readily come to mind.

Other expansion of applications are looked for in power conversion, high-frequency heating, motor control, electronic calculators, and so on. At the end of the war a situation may arise which is quite unusual: "Tens of thousands of men who have joined the military services or are in government employ," states *Electronics,* "are acquiring knowledge and experience on electron tubes and electronic devices at ultra-high-frequencies. These men with knowledge and skill will return home with up-to-the-minute knowledge so that those who remained at home in industry will be at a relative disadvantage and will have much to learn to keep abreast in the electronic field."

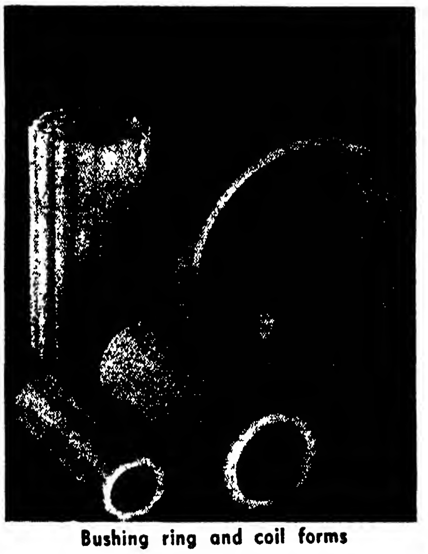
The advantages of high-frequency heating equipment, using electron tubes, are now being more generally appreciated Surface hardening of small steel parts has introduced the subject into the industrial field, where it will undoubtedly spread to other applications as it becomes better known and understood. An important factor, it is pointed out, is that high-frequency heating can be made selective, so that there is heating of only certain portions or materials of the body in the high-frequency field. The value of this aspect of high-frequency heating will come to be more generally recognized and utilized. Then, too, certain industrial processes may be effectively handled only by this means.

For a number of industrial applications requiring small electric motors, the D.C. motor still has certain desirable characteristics that cannot be duplicated with any type of A.C. motor. This is particularly true for certain light machine-tool applications. On the other hand, A.C. distribution systems are becoming more universally employed, so that the localities where small D.C. motors can be directly utilized are very limited. The electron tube steps in as an almost perfect solution to this problem. It provides variable voltage D.C. from constant potential alternating current. Such electronic motor control equipment even provides characteristics not readily obtainable from a straight D.C. supply. Tubes have a bright future here.

INSULATION
Made by New
Glass Process

A NEW line of electrical insulation known as Multiform Insulators provides the American electrical industry with a new insulation supply at a time when war requirements are straining existing facilities. The manufacturing process for producing these insulators, developed by the Corning Glass Works, has kicked out the window many production barriers that have faced the glass industry throughout its long history.

Conventional glass-making methods—blowing, pressing, and drawing—have pro-



Bushing ring and coil forms

duced, to be sure, a multiplicity of glassware. But the glassware made by these conventional methods has had definite limitations, a major one being that shapes have had to be relatively simple. Further, special design features such as holes, grooves, or threads have been major headaches for glass men. The glass industry has made many glass parts with these features—but in almost all cases it has been a slow and expensive operation. It has also been difficult with conventional glass-making methods to hold close tolerances that could enable glass parts to compete with metal parts.

The result of these limitations of shape, design, and accuracy has been that the use of glass has been precluded in many instances where the qualities of the material have been ideally suitable. In the insulation field, for instance, the remarkable electrical qualities of glass have, in the past, been put to use only in insulators of comparatively simple shape—such as standoff, strain, or bowl-shaped entering insulators—that were adaptable to conventional manufacturing methods. There has remained outside the reach of glass, consequently, the great bulk of the insulation field—the thousands of intricate-shaped insulators that go into radio receivers and transmitters, refrigerators, and other electrical equipment. The new Multiform process has now made electrical glass available for insulation in a wide variety of shapes.

The Multiform process involves a combination of cold-molding batch materials and subsequent fusing. Finished ware, in contrast with the more familiar types of glassware, is opaque or translucent; but it is a true glass. The process has made available products that run the gamut from small insulating beads, several thousand to the pound, to large insulators weighing 25 pounds or more. Countersunk and tapped holes are practicable, as are both external and internal threads and grooves.

In addition to a wide range of shapes and sizes and special design features, these products can be made accurately to close tolerances and from almost any glass composition, the choice depending upon the qualities required. Insulators made by the Multiform process are somewhat less strong mechanically—under comparable conditions—than products of the same composition fabricated by conventional glass-making methods The mechanical strength has proved adequate, however, for a very broad group of electrical insulators.

In dielectric strength, the new insulators have slightly lower values than do conventionally formed products of the same composition. The dielectric strengths—500 volts per mil or more—are sufficient, however, for all ordinary applications and, generally, are much higher than the dielectric strengths of other ceramic products. Among the advantages claimed for Multiform insulators are minimum frequency drift, negligible water absorption, and low loss factor.

AIR JARS BOLTS
Millions of Vibrations Test
Holding Qualities of Nuts

IF YOU cannot jar a nut off a bolt after 3,000,000 sharp jolts, no amount of jarring will remove it. Upon this theory The Tinnerman Products, Inc., test their self-locking speed nuts which the company produces by the million for airplanes and other war machines of the United Nations. Occasionally more severe tests are made—as many as 10,800,000,000 vibrations.

The testing machine developed by the company uses an air hammer to vibrate a steel bar about two feet long and two inches wide. The bar is clamped onto the piston of the air cylinder, and the nuts are fastened onto plates carried by the metal bar.

A hand screw-driver is used to tighten the bolts with a force that would ordinarily be used by a factory worker.

The armature carrying the speed nuts under test is vibrated by the air cylinder

Self-locking speed-nuts are jarred

at an amplitude of 1/16 of an inch. The frequency of the vibration is measured by a vibrometer, as shown in the illustration, and is adjusted to 3500 cycles per minute. The tests are run on an average of 35 hours, but some are conducted for as long as 1000 hours.

SCRAP HAULING

Reduced by Application of New Finishing Program

In an effort to speed aircraft production and reduce the transportation of aluminum scrap, the Reynolds Metals Company has adopted the plan of stamping and finishing metal airplane parts at its factory rather than shipping the raw aluminum stock to the aircraft plants for processing there, the Aeronautical Chamber of Commerce of America reports.

Parts are being routed, stamped, sheared, and shaped at the Reynolds plants, and the scrap produced in the process is sent back to the furnaces for reclamation virtually under the same roof. Further efficiency is achieved by utilizing small pieces of scrap for shaping smaller parts.

Officials of the Douglas Aircraft Company's midwest plant, where Reynolds pre-fabricated parts are now in use, declare that the plan has already effected vast savings in production time, facilities, and costs.

Burt C. Monesmith, materials superintendent at the Douglas works, estimates that from 100 tons of raw aluminum stock which might go to an aircraft plant, not more than 70 tons of it can be worked into finished parts—leaving a scrap residue of 30 percent. Such scrap ordinarily has to be shipped back to the aluminum mill for remelting.

The plan to eliminate this cross-hauling of waste aluminum was devised by R. S. Reynolds, president of the aluminum firm. This company, although it has been in production for but three years, is now turning out more of the metal than did France and England combined as late as 1939.

NICOTINE

Sources Being Sought as Shortage Develops

With an estimated shortage of 300,000 pounds of nicotine, chemists are seeking new sources of what used to be a surplus commodity, according to *Chemical and Engineering News*. An unprecedented demand for nicotinic acid, a part of the vitamin-B complex, to fortify white flour, and restricted importation from the Pacific of the insecticides pyrethrum and derris, which can be replaced partially by nicotine, have created the nicotine shortage, it is pointed out by M. J. Copley, R. K. Eskew, and J. J. Willaman of the United States Eastern Regional Research Laboratory, Philadelphia, which has undertaken a research program to find more extended industrial uses for tobacco. There also has been an increased agricultural use of nicotine for food production.

Practically all of the million pounds of nicotine recovered annually in this country has until recently been used in insecticides. Now new and more efficient nicotine insecticides are sought to replace derris and pyrethrum. A jump from 10,000 pounds of nicotinic acid produced in 1940 for the treatment of pellagra to an estimated 200,000 pounds for flour fortification this year has eaten up supplies of nicotine, the best known material for making nicotinic acid.

In an attempt to make up the deficit, a considerable poundage of low-grade tobacco of certain types will be diverted from the ordinary leaf channels to nicotine manufacture. Another possible source is the growing of *Nicotiana rustica*, a species of tobacco which is not used for smoking in this country and contains about twice as much nicotine as ordinary tobacco.

"Rustica has been grown experimentally for a great many years in various parts of the country and constitutes a potential source of an appreciable amount of nicotine," it is declared.

"When the laboratory's research program on tobacco was first started," the research workers declare, "the viewpoint was almost wholly that of finding more extensive uses for a surplus commodity. It was felt that more extended use for nicotine, for example, would consume more of the lower grades of tobacco and maintain a better price for the other grades. The change in world conditions, however, has now altered this picture. Instead of wondering how more nicotine could be used, we are wondering where sufficient nicotine can be obtained."

The chemists feel that it would be hazardous to predict where the nicotinic acid of the future will be obtained, but that nicotine is still a logical source. Main objectives are more economical recovery of nicotine from tobacco and improvement in the oxidation of nicotine to nicotinic acid. Quinoline and betapicoline are also possible raw materials for nicotinic acid, and a race has developed among these three starting materials.

LEATHER

Tanning Requirements Being Met by Research

Old king Solomon, slipping back over the Styx for a visit now, would surely revise his oft-quoted "way of a man with a maid" verse. Since in it he proclaims only four things "too wonderful" for his comprehension, today he could hardly escape raising the ante to five. He'd surely have to include the wonders of research with, at times, startling connections between unrelated industries.

Latest of these examples appears to be use of spent pickle-liquors from steel mills for tanning leathers. Research directed toward utilizing spent pickle-liquors for possible iron-chrome tannage was eagerly pursued some months ago in view of dwindling chromium stocks, and the fact that about 50 percent of the total United States leather output is chrome-tanned.

Increasing production of domestic chromium ores of non-metallurgical quality is relaxing restrictions so the tanning and chemical industries seem to be assured of ample supplies. Although successful iron tannage would save about 30 percent of normal chromium requirements for tanning, research on spent pickle-liquor tanning has somewhat abated Leather from steel mills is not so imminent as it was a while back; it still remains a future possibility.

Interruptions of vegetable tanning material imports, however, are cause for concern, even though an earlier trend toward use of domestic tannins has helped keep the situation from becoming too acute. Converted to a 25 percent tannin content, our consumption of vegetable tannins amounts to about 800 million pounds annually, of which foreign types accounted for 60 percent though the ration recently was reduced to 50 percent. Sharp curtailment of available cargo space for delivery of even South American tanning materials —quebracho, divi divi, tarra, and others—further forces larger production of domestic tanstuffs.

Production of chestnut extract, already popular, has increased and investigations of canaigre root, domestic sumac, hemlock, and mangrove are under way. Mangrove bark with a tannin content of 30 percent is available in large quantities in Florida, but high costs of gathering and shipping to extract plants may prove an obstacle to utilization.

However, chances are good that research will solve the tanstuffs problem, and at the same time foster another industry to further extend our future self-sufficiency.—*The Chemical Digest.*

INDUSTRIAL TRENDS

AS RUBBER GOES

WHEN Japan started her drive into the rubber-growing areas of the Far East, she dealt a blow to the rubber industry of the United States, creating a serious shortage of crude rubber. With the industry rapidly gearing itself to war-time production, this blow seemed, for the moment, to be the end, to be the one thing that could mean the difference between final victory and defeat. Rubber was vital to many war machines. Without rubber, we were licked before we really got started.

But as time went on and opportunity presented itself to take stock of the situation, there came the realization to many that the blow was really to be considered as an aid to the United States in more ways than one. Regardless of how the factors of speed may be viewed, often in the light of political leanings, a synthetic rubber industry sprang from the laboratories of the United States.

Although it is not possible to make direct statements as to synthetic rubber production at present or in the immediate future, it is an open secret that plants now being constructed will have sufficient capacity to more than fill the country's requirements of today and many tomorrows. What will be the base from which it is made is still a question, although the petroleum advocates appear to have most of the convincing arguments on their side. This in spite of dwindling petroleum reserves, since it has been established that to make sufficient butadiene to produce 800,000 tons of rubber a year (our largest annual consumption in pre-war days was 765,000 tons) would would demand only some 2 percent of our largest peace-time production of petroleum.

Synthetic rubber is even now meeting the tests on the toughest proving grounds in the world—war. It is, of course, being tested in tires and, reports have it, is showing up remarkably well. Then it must be remembered that synthetic rubber has many desirable qualities not found in natural rubber. Among these are resistance to the attacks of gasoline, oils, and other solvents of natural rubber, better aging characteristics under adverse conditions, greater adaptability during manufacture to definite ends, and so on.

From all this it becomes apparent that synthetic rubber has an unlimited future, if other factors do not interfere too much. For example, there is the question of what will happen to the synthetic rubber industry when natural rubber once more becomes available. Tariffs may be erected to protect the industry if, by that time, the price of synthetic has not been reduced sufficiently to make it a direct competitor of natural. Or it may work out that the Far East will be so badly in need of re-established markets that natural rubber will reappear in the United States, while the synthetic industry will receive the artificial respiration of subsidy, again assuming that a price differential exists.

However the financial angle works out, it is now certain that synthetic will find substantial post-war markets, whether alone or in combination with the natural product. Already the laboratories are working on the problem of adapting existing—but frozen—markets to synthetic rubber for after-the-war operations. At the same time, new markets are being developed.

Itemizing a few of the known possible uses of synthetic will point the way sufficiently to indicate the enormous markets which the material can command in days to come: Rubber springs for vehicles, with all the obvious advantages over metals; long conveyor belts for use on huge construction projects, speeding up work and reducing labor requirements; rubber containers and container linings for transporting liquids; water pipes that will stretch when frozen but will not break; women's hose that will have astonishing wearing qualities; tubeless tires—the list could be extended indefinitely to include uses that will affect the daily lives of every man-in-the-street.

WHERE IS OIL HEADING?

THE SEEMING gigantic inroads that the present war is making in our crude-oil reserves were hinted at in the preceding note on synthetic rubber. Just how big a dent will be made cannot be foreseen at the moment, but that it will be big indeed is to be guessed from the way in which the petroleum industry is tightening up its operations and giving the gun to research work aimed at higher efficiency in processing as well as at the discovery of new resources.

What we are directly concerned with here is that, on the eve of a breath-taking expansion of the chemical industry based on petroleum as a raw material and dealt with on this page in past issues, there appears on the horizon a possibility of developing shortages in the raw material itself. These shortages, however, despite the furore that they have caused in the daily press, are not too serious when viewed in a calm over-all survey.

It is true, indeed, that since 1938 we have been using petroleum in this country in excess of the amounts discovered. Obviously, since oil is not a crop that can be planted year after year, if this keeps up indefinitely things are going to be bad. There are, however, other answers. Proved oil areas are being drawn on as much as possible, and new explorations are not keeping pace. The reason here is the gamble involved in exploration, plus increased cost of the work and priority restrictions, all tending toward a reluctance on the part of oil gamblers to risk too many dry holes. This angle is being attacked by the government in the form of encouragement of wild-catters, encouragement which may soon bear fruit. Then, too, there is the fact that all oil is not the best for all purposes. Some of it will produce high-octane gasoline, while oil from other fields will not. Conversely, some oil is better as the chemical industry's raw material mentioned before, so that there appears to be some chance here of a set of checks and balances that will help in the long run.

Then there are other ways of oil conservation that are being put into effect. For example, natural gas, often wasted, is being put to use as a replacement for oil in heating, where distribution and storage means make this feasible. Oil-shale deposits are known; other new ones, notably in Alberta, have been discovered and are being worked. Coal as a source of oil has been known for a long time, and can easily enter the petroleum picture when the pressure becomes too great.

Here, it would then seem, the big war dent being made in our oil resources—while it is no figment of the imagination by any manner of means—is not one which spells disaster to the petroleum industry or which means that John Public has been permanently taken out of his automobile and put on his feet for local locomotion. What the dent really means is that the industry as a whole is working more directly toward efficient conservation rather than with no thought for the needs of tomorrow.

HOW STEEL IS ORDERED

A NEW TREND in the steel industry, brought about by the exigencies of war-time production, bids fair to inaugurate an entirely new method of specifying a particular type of steel desired by a steel user. At the turn of the century alloy steels were almost unknown, the user merely specifying that he wanted soft, medium, or hard. Then came World War I, with a tremendous rise in the demand for steel, both as to quantity and quality. Alloy steels came into their own and users started to order steel by specifying its exact chemical formula. In some cases a steel order would be received by a producer in which several different types would be specified, differing from each other by only a fraction of a percent in one or more of the alloying metals.

Such procedure, of course, complicated steel making to an enormous extent. When World War II stepped up the demand for all types of steels, however, these wasteful measures had to be curtailed; shortages of certain alloying metals, also, led to the realization that steels could efficiently be ordered by specifying their physical properties rather than exact chemical formulas. This method is being found quite satisfactory to the consumer as well as to the producer and is now being followed in many industries without letting down on quality in any respect.

—The Editors

At 9 A.M. three trucks (upper left) rolled onto the building site, carrying all the material for the construction of a six-room house, as described below. By 10 A.M. the flooring had been laid over the foundations that had previously been prepared. At 10:30 A.M. the center section was raised into place. The photo above shows a close-up of the work in progress, taken between the last mentioned hour and 12 o'clock noon, at which time the roofing panels and sheathing were going into place, the ceiling sections having already been set. By 3:20 PM the building was completed and ready for occupancy, as at left. The success of this method of construction rests on the application of many "tricks" such as those described below, including the use of double-headed nails, pre-fabricated wall sections which slide into place, framing sections, and so on

A House in Six Hours

Three Trucks Haul All Materials for a Six-Room House Which Is Put Together With Double-Headed Nails

PROVIDING a six-room home for two families in less than a full working day is illustrated in the accompanying pictures showing three phases of demountable house erection operations for war workers in South Carolina. Ten men, including six carpenters and four laborers, put together the house shown in the six hours and 20 minutes between 9 A.M. and 3:30 P.M.

The materials for the entire house just filled three trucks (shown in the first picture). The wall sections, ceiling sections, roof parcels, partitions, and other major units were pre-assembled in the contractor's mill and, as loaded on the trucks, were ready to be put together according to a simple numbering system.

First step in construction was placing of flooring over foundations that were laid out and prepared ahead of time by other work crews, who also put down sewer and water lines.

Text and illustrations courtesy "Engineering News-Record."

The first section to be put up was the center partition dividing the house into separate dwelling units for two families. One of the key construction principles of demountable housing used in these structures is the use of short metal straps, with holes in each end to receive double-headed nails. Rows of these straps tie the walls to the foundation, brace the corners and perform other strengthening functions. The double-headed nails—the only kind used in these homes—provide a major part of the demountable element. The first head is driven flush with the strap or the wood, while an offset section of the nail allows another head to remain projecting. This projecting head permits all nails to be drawn easily and rapidly without damage to the structure, should need for demounting or removal arise.

Extending toward the lower foreground of the second photograph above, along the floor, are two narrow wooden strips. The strip on the left has already been nailed in place, to mark the position where a partition will be erected Each wall section, partition, and other unit of these demountable houses has a groove in its edge that fits over strips such as these Entire prefabricated walls can be slid into place by this tongue-and-groove principle, and, when set, the sections are tied down by the metal straps and double-headed nails.

Another feature is the use of Upson board on the partitions and inner sides of wall sections. Outside coverings of the sections are of three-ply plywood.

The section of framing at the left center of the second picture is a special section, left without covering at the mill in order to make easy the installation of pipes and electrical conduit. These pipes and lines are installed while erection proceeds, and as soon as the installation of utilities is finshed, the wallboard covering, precut to fit, is nailed over the bare framing.

By noon of the day of erection, the house was well on its way to completion. All of the wall panels as well as the inside partitions had been erected; windows had been set and gables erected. The ceiling sections had been set in place above the rooms and the first roof panel had been placed. A protective layer of asphalt felt is placed over the roof boarding before shingling.

By 3:20 P.M. the building was complete, with asbestos shingling on the walls and asphalt shingles on the roof. Doors were hung, porches and steps added, and other details completed. Landscaping, however, remained to be done, and plumbing and electric fixtures were still to be attached to connections that were already in place. Contractors on this project—a part of a 2400-unit project—are Skinner and Ruddock of Charleston.

Fighting Fires Aloft

Precautions Taken on the Clipper Planes to Reduce Fire Hazard to an Absolute Minimum

If, by any remote chance, fire should break out in one of the four 1600-horsepower engines of a Pan American Clipper on a transatlantic flight, it's a safe bet that passengers wouldn't even know it. For the flight engineer would step calmly to a control board, turn a valve, and put out the fire with a blast of flame-smothering vapor.

That's how well-organized the fire-protection equipment is set up on these 42-ton flying boats that pioneered America's aerial life lines to Europe, Africa, and Asia. So carefully have Pan American engineers planned for every eventuality that this great airline has, for example, completed approximately a thousand transatlantic crossings without a single fatality or serious accident due to fire.

The way this ingenious fire-protection functions can be seen during the regular "turn-around" overhaulings which the Clippers get at the Marine Terminal of the New York Municipal Airport at the completion of each transatlantic trip These overhauls, which involve going over the entire ship with a figurative fine-tooth comb in less than 24 hours, also include frequent inspections and testing of the fire-extinguishing systems.

First step in the fire system's check-up is the removal and weighing of the carbon-dioxide cylinders—the heart of the extinguishing equipment. These containers, which hold liquified carbon dioxide under terrific pressure, provide the vapor which is capable of smothering an engine fire even though the plane is in full flight miles above the Atlantic. If the cylinders show the prescribed weight, the inspector knows that no leakage has occured during previous flights and an adequate supply of the liquid is available.

Another step in the check-up system, but which is done at less frequent intervals, is complete discharge of the carbon dioxide through the plane's gas distribution system. One of the hundreds of maintenance engineers who swarm over the Clipper during these speedy overhauls aims the control valve first at one motor then at the others in order to make sure that the vapor instantly reaches the scene of potential fire. Other engineers stand by each nacelle to check on the gas discharge, which also serves to remove any dirt accumulations from the piping and shows up possible leaks.

This piping leads almost directly from the carbon-dioxide cylinder to the four engines, but passes through the control panel where the flight engineer can set his valves to discharge the gas into any one burning engine. A double carbon-dioxide container is also provided to give a burning engine a second shot of gas in the event that the first one does not completely extinguish the flames.

In addition to this unique built-in fire extinguishing system, each clipper also carries portable carbon-dioxide guns in each engine nacelle. These portable units, which have pistol grips and triggers, each contain two pounds of liquid carbon dioxide and are used like a "Tommy" gun for fighting localized fires within the wing cavity or engine compartments, all of which are accessible to the crew during flight.

The way in which carbon dioxide works is worthy of note. Discharge of the liquid, which instantaneously becomes a gas when it hits the air, reduces the oxygen content of the air to 15 percent or less, at which point most fires cannot burn. Even in the terrific air blast entering the radial engines during flight, the gas effectively reduces the oxygen content for a few split seconds—long enough for the flames to be snuffed out and remedial measures taken to prevent re-ignition

Right: **The control panel from which any one of the four motors on a Clipper ship can be flooded with carbon dioxide gas.** ***Below:*** **An unusual photograph of a Clipper motor enveloped in a fog of fire-smothering gas during a test discharge.** ***Lower right:*** **Preparing to weigh carbon-dioxide containers during a routine check**

Planet Companions

Three Faint Companions of Stars Are Half Way In Mass Between a Star and a Planet

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate at the Mount Wilson Observatory of the Carnegie Institution of Washington

ASTRONOMICAL discoveries of importance are sometimes, though rarely, made at a glance—as when a dozen people recognize a nova which has grown to brightness overnight. More of them arise from a planned and deliberate search, such as that of Pluto, after hundreds of thousands of star-images had been inspected, in a photographic campaign so designed as to assure the ultimate discovery of a distant planet, if one bright enough to be observed existed. The most renowned of all such discoveries—that of Neptune—came in yet another way, as a result of the application of painstaking calculations to long and accurate series of observations made for other purposes, with no thought of the discovery to which eventually they led.

A discovery of unusual interest, made in this last way—indeed, two of the same kind—has just been discussed in the technical literature and, under the principle which has always ruled in these columns, become available for discussion

Two observers, working independently, have found that two different stars among our nearest neighbors are attended by companions, in orbital motion about them, which are of such small mass that it is practically certain that they are dark bodies, and have a good claim to be called planets.

It has long been realized that, if the stars have planets circulating around them, there is no hope at all of detecting them as we observe the planets of our own system, by reflected light. A planet twice the diameter of Jupiter and distant from the nearest star, Alpha Centauri, as far as Jupiter is from the Sun, and shining by reflected light, would appear to us like a star of the 21st magnitude—that is, barely bright enough to be photographed with a 100-inch telescope, under the best conditions, if it stood alone on a dark sky. It would actually be within a few seconds of arc of its primary, whose light, a hundred million times brighter, would drown it out hopelessly.

There is, however, another way in which a planet might reveal its presence. If any two bodies, such as the Earth and Moon, form a pair in orbital motion, the gravitational attraction of the Earth on the Moon, measured in units of force, is exactly equal to that of the Moon on the Earth; but the motion of the more massive body is less affected by this equal force. Neither one describes an orbit about the other as a fixed center; but both circulate in orbits of the same shape but different sizes about their common center of gravity, keeping on opposite sides of it The Earth is (in round numbers) 80 times as massive as the Moon; so that, while the Moon describes its orbit at a distance of 240,000 miles from the common center, the Earth (more precisely its center) circulates about this point in an orbit a little less than 3000 miles in radius.

It is the center of gravity which describes an orbit about the Sun, in accordance with Kepler's laws. Should we calculate the motion from these laws, we would find the actual Earth at new Moon 3000 miles farther from the Sun than the predicted value. At the full phase, when the Moon is outside the Earth's orbit, the Earth is 3000 miles inside. At first quarter the Moon is behind and the Earth ahead, and so on

NOW MAKE, for the moment, the physically absurd asumption that the Moon was absolutely black, reflecting no light at all. Only the Earth would be visible to a distant observer. We may imagine him looking from such an angle that the Moon never eclipses the Earth, even partially Even so, he could discover the Moon, by making a sufficiently long and accurate series of observations of the position of the Earth relative to the Sun. Comparing them with theoretical motions in an elliptic orbit, he would find that, whereas this satisfied the observations of the other planets, the Earth's motion would show a small but persistent oscillation, in a period of 27 1/3 days (one sidereal month). He would thence conclude, correctly, that the Earth was attended by an invisible satellite having this period

If he could find the Earth's mass in some other way—say by the effects of its attraction on the motion of the other planets—he could then calculate how far away this satellite would have to be to possess the known orbital period. This distance would come out 80 times the radius of the observed oscillation, and he would then be sure that the Earth was attended by an invisible satellite 1/80 as massive as its primary.

The alert reader of this analogy will naturally inquire why it is said that the observations of the other planets would not reveal deviations from Kepler's laws, although most of them have satellites. The answer is that the masses of these satellites are but a very small fraction of those of their primaries, 1/3500 for the largest satellite of Saturn, and at most 1/10,000 for the satellites of Jupiter. The resulting oscillations would be too small to be detected. (A small oscillation of Neptune, due to the atraction of its one known satellite, has actually been observed.)

This illustration has been developed at length, because it illustrates fully the principles which must be applied in the case of a star. A very small satellite will produce too small an effect to be observable. The detection of small oscillations, and hence of small attendants, demands two things. First, the star must be one of our near neighbors in space. For similar physical properties of the system (period and masses of the two components) the range of the oscillations, in miles, will be the same. The nearer the star, the bigger will be this oscillation, measured in hundredths of a second of arc upon the heavens.

SECOND, our observations must have the highest possible accuracy—that is, they must be based on photographs made with telescopes of long focus The technique of such observation has been fully developed Results of high accuracy, with an average error of about 0".03 from a single plate, can be obtained by comparing the measures of stars not more than 10' or so apart in the sky, so long as these are of about the same brightness—or reduced to the same brightness by some device which does not distort the images. But still more accurate measures, with an average error about 0".005, can be made of the relative positions of the two components of a double star; provided that these are nearly of the same brightness. In this case, dozens of exposures of the pair can be made and measured on a single plate, and the average result from two or three plates may reach the remarkable accuracy just stated

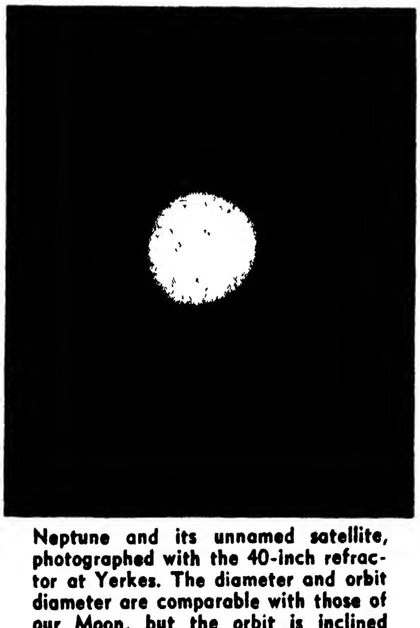
Observations of both these types have been made in great numbers—in the first case to determine the parallaxes of stars, and in the second, to study the motion of binary pairs. It is usually found that the observations are represented, within the limit of their accuracy, by motion in an elliptic orbit in the second case, and by rectilinear motion in the first, combined with the apparent oscillation resulting from observation from the moving Earth. But sometimes these standard assumptions prove insufficient to account for the measures, and it is evident that some additional motion is present—which, when the observations are continued long enough, turns out to be a periodic oscillation.

The oldest examples of such behavior were found nearly a century ago for Sirius and Procyon. Here the oscillations are so large that they can be detected even with the relatively low accuracy of meridian observations. Bessel showed, long ago, that Sirius must have a companion revolving about it in a period of about 50 years, and Procyon in one of 40. Both these bodies have since been seen with powerful telescopes, and followed through a whole revolution. The companion of

Sirius has a mass nearly equal to the Sun's; that of Procyon is one third as great. They are faint, but self-luminous stars—excellent examples of the now well-known white dwarfs

A few more cases of the same sort have been found in the course of parallax observations. A notable example has just been found by Dr. Reuyl, of the McCormick Observatory, at the University of Virginia. It is a faint red dwarf star, known as Cincinnati 1244, since this is its number in a star-catalogue published by that Observatory. Observations from 1915 to 1942 are now available, and show that, after allowance for a proper motion of 0".490 per year and a parallax of 0".201, there remains an oscillation with a period of 26.5 years, corresponding to motion in an orbit of eccentricity 0.6 and with a mean distance of 0".11 between the bright star and the center of gravity, which corresponds to an actual distance of only 50,000,000 miles.

To find how far off the companion is on the other side, the mass of the visible star must be known. For faint red dwarfs of this sort, there is a close relation between the mass and the real brightness The latter is 1/35 of the Sun's and, by comparison with other known cases, the mass should be 0.35 times the Sun's It follows from Kepler's laws that the mean distance of the invisible companion from its primary should be 600,000,000 miles. The invisible star is therefore 11 times as far from the center of gravity as the visible one, and should have but 1/11 of its mass, or a little less than 1/30 of the Sun's. From the general run of the relation between mass and brightness, there can be no doubt that a star of this very small mass would be unobservably faint.



Neptune and its unnamed satellite, photographed with the 40-inch refractor at Yerkes. The diameter and orbit diameter are comparable with those of our Moon, but the orbit is inclined at about 40 degrees to that of the planet and the orbital motion is retrograde—that is, from east to west

	A_8 0.00	B_2 7593.16	C_0 7750 75	D_1 7810 79	E_2 7927.46	F_3 8095 24	G_4 8307 61
j_1 30787.30			23036.52	22976 52	22859 86		
k_2 30858 77				23047 95	22931.30	22763 57	
l_3 30965 42					23037.94	22870 19	22657 83
m_4 31106.35						23011 12	22798 75
n_5 31280 37							(22972 72)
o_0 33338.26				(25527 47)			
p_1 33423.81			25673 05	25613.01	25496 36		
q_2 33542.12				25731.31	25614.61	25446 95	
r_3 33671 57					25744 08	25576.37	25363 96
s_4 33816.13						25720.92	25508.48
t_2 27728 82	27728.80	20135 67			19801.36	19633.61	
u_3 27820.24	27820.20	20227.07				19725 04	19512.62
v_4 27935.26	(27935.26)						

Answer to last month's spectroscopic "cross-word puzzle." Numbers in parenthesis are "unkeyed" and added to show how they go. All are keyed into the large diagram

Double-star observations, however, have revealed still more remarkable objects. Dr. Strand, of the Sproul Observatory at Swarthmore, has made a number of very thorough studies of these, described in Scientific American, March 1942, page 135, including one of the famous system 61 Cygni, consisting of two stars, one twice as bright as the other, in orbital motion with a period of 720 years. This is one of the nearest stars in the sky (parallax 0".294, distance 11 light-years). The two components are nearly equal in mass, 0 58 and 0.55 times the Sun's mass

Precise photographic observations of this pair have been made since 1914 by various observers. Both these and the earlier, less accurate visual observations, were used by Strand in computing his orbit—a task which required weeks of laborious calculation. When the calculated and observed positions were compared, a small, but unquestionable, oscillation appeared. Only observations of the highest precision could have detected it, for its extreme range is little more than 0" 03—which, on photographs taken with a telescope 30 feet long, corresponds to but a 20,000th part of an inch. Compared with the positions calculated from the large orbit, the star drifts slowly eastward for 3.5 years, swings back westward in less than half this time, and repeats the process with a period of 4.9 years. The inequality of the two intervals shows that the orbit of the close pair is highly eccentric. The north-and-south motion is smaller, but definite. Combining them, Dr. Strand finds that the bright star moves around the center of gravity of itself and the invisible companion in an orbit of eccentricity 0 7 nearly edgewise toward us (inclination 80°). The mean radius of this orbit is 0".020 (allowance being made for effects of foreshortening) At the star's distance, this corresponds to 6,300,000 miles—by all odds the smallest orbit as yet known among the stars

So far the situation is absolutely clear; but it is not yet known which of the two visible stars has the dark companion. The measures give only the relative position of the two, and this is equally affected by an eastward shift of one as by a westward displacement of the other by the same amount. There are two ways in which this uncertainty might be dispelled Measurements of the positions of both stars, relative to others in the field of view, would show which one is moving uniformly, and which shows the oscillation; but, even on the best photographs, the much larger distances involved could not be measured with the extreme accuracy required. A second way is more hopeful. The motion of the star in the small orbit would alter its velocity toward or from the Sun by a maximum range of a little more than one kilometer per second. This is easily within the accuracy of measurement of powerful spectrographs The next favorable opportunity will come in 1946 and 1947; and after that, we may know which star has the companion.

The most interesting question, namely, what is the mass of the companion, need not wait for an answer, for the masses of the two bright stars are so nearly equal that the distance of a companion revolving about either one in a period of 4.9 years would be substantially the same, 223,000,000 miles. This is 35 times the distance of the bright star from the center of gravity. Hence the mass of the companion must be 1/34 of that of the brighter star, or 0 016 times the Sun's mass.

This is only one tenth as great as the smallest mass that has even been observed in a visible star, and 16 times the mass of Jupiter—so that the newly discovered body may at least be described as half way between a star and a planet

When its discovery was announced by Dr Strand at a meeting last winter, it stood quite alone, as by far the least massive body known to exist outside the solar system. Since then it has found a rival. Dr. Reuyl, from similar photographic observations of the binary star 70 Ophiuchi, finds a similar small oscillation, with period 17 years, and half-range 0".015 The parallax is 0" 20, so that the distance from the center of gravity comes out 7,000,000 miles. This is an approximate value, as it has not yet been practicable to determine the eccentricity of the small orbit.

As in the preceding case, it is not possible at present to tell whether the companion belongs to the brighter or fainter star of the visual pair. In the first case, its mass comes out 0 012 times the Sun's; in the second, 0.008.

Here, then, we have another body of almost planetary mass. The question whether it should really be called a planet is one of the most interesting which has been before the astronomical public for a long time; but its discussion must be postponed till next month. — *Manitou Springs, Colorado, March 22, 1943.*

New Key to the North

When Peace Comes, the Alcan Highway Will Unlock Nature's Rich Storehouse of the Great Northwest

A. D. RATHBONE, IV

JUST 150 years ago this spring the first white man ever to cross the American continent north of Mexico stood near what is today the southern terminus of the Alaska, or Alcan, Highway. In the wildest flights of his imagination—and his was, indeed, an active mind—he could not have conceived that Fort St. John, then a tiny trading post on the Peace River, would one day become an important way-station on an 1800-mile highway vital to the defense of his native Great Britain and her allies. Nonetheless, that canny young Scotsman, Sir Alexander Mackenzie, had fought his way up hundreds of miles of the Peace River in 1793 for the same reason that motivated a meeting of representatives of the United States and Canadian governments 140 years later.

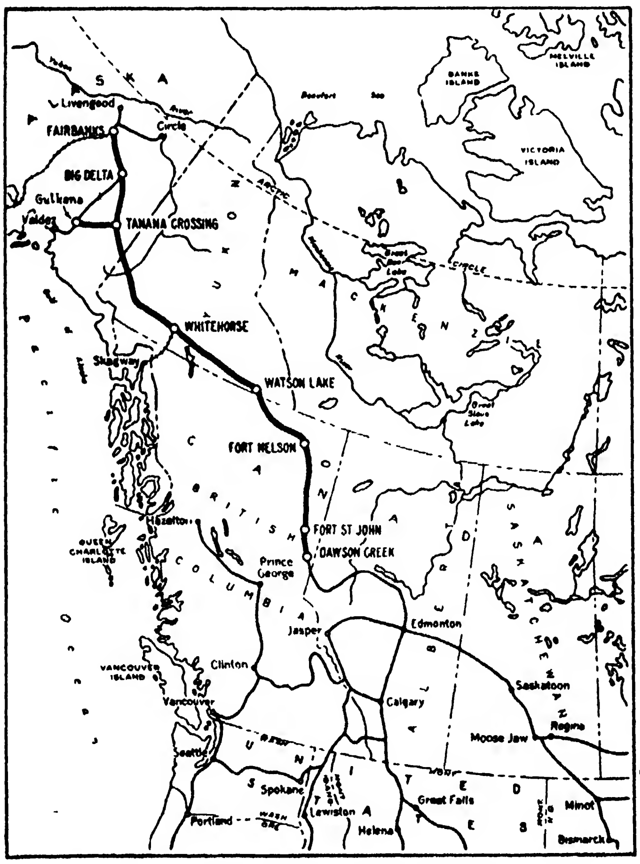
The intrepid explorer and the joint committee of 1933 were both searching for practical routes that would further the economic development of their respective nations—one of man's major activities from the earliest age of barter and exchange to the vast ramifications of today's international trade.

Seldom have the economic lives of two great countries been confronted with so many varied possibilities of future growth through the opening of a single new trade route as have Canada and the United States by completion of the Alcan Highway—and probably never has such an important link been put into service with comparable scientific ingenuity and speed.

So long as the necessities of war utilize the facilities of this new, and as yet incomplete, road to the utmost, it may be too early to attempt specific prophecies as to its after-the-war use, but certainly it is not premature to speculate on general peacetime possibilities, especially when such speculation can be based on known facts concerning feasibility of agriculture, mining, manufacturing, exploration, and recreation in this newly opened area. As to settlement and investment of capital necessary to foment development of this hitherto little known section of the continent, history is crammed with stories of the call of the frontier. When this newest call comes after the war, it seems unlikely that it will go unheeded.

What is there about this latest highway engineering miracle besides its present strategic use and the romance of its construction that would cause present speculation regarding its future adaptation? After all, there is a railroad network throughout the more populous section of Alberta Province; more sparsely settled British Columbia is also served by the "Iron Horse;" the great Mackenzie-Athabaska-Peace River system is splendidly organized for water-borne commerce during the warmer months; Canadian and Alaskan commercial aviation has performed winter and summer impossibles for many years. Why, then, should an 1800-mile road, traversing some of the wildest parts of British Columbia, Yukon Territory, and Alaska, be of such potential economic interest to the future—save, perhaps, to anglers and hunters?

Primarily, the answer lies in sudden and drastic war-wrought changes in transportation methods, by sea, on land, and in the air. Thousands of tons of freight must be moved as rapidly as possible between points not heretofore considered in the same traffic category, or, at least not served by adequate facilities. Motor truck roads which, under normal peace-time conditions, would be considered too costly, or unfeasible for other reasons, are built over mountains and across deserts. In many of these instances it is entirely reasonable to expect the consequential effect which such strategic highways must exert, as they have always exerted, on the lives of the existing population in the area thus served, and on the lives of those who, because of increased ease of transportation, will become residents of the area. Particularly has this been true if the newly served section contains natural resources and agricultural possibilities. These abound in Alberta, British Columbia, the Yukon Territory, and Alaska, despite popular conception that much of the Great Northwest consists of impassable muskeg, impenetrable forests, unsurmountable mountains—all cloaked in a climate too rigidly frigid to grow anything but icicles throughout most of the year.



Route of the 1800-mile Alcan Highway

Even the young Mackenzie, in 1788, wrote in his journal of luxuriant growths of garden produce in far-north Alberta. He mentioned turnips, carrots, parsnips, potatoes, cabbages, and said: "There is not the least doubt but the soil would be very productive." It has been all of this, and with a vegetation generally comparable with that of Maine and a winter climate less severe than that of North Dakota, Alberta has progressed far in farming and stock raising since the days of the fur traders.

More recently, however, the Province has claimed a place among mineral-producing states of this continent. Surveys of newly discovered northern oil sands brought estimates of from 100 to 250 million barrels, of which about 1 percent is at present economically available Said the Edmonton Journal, editorially: "The federal (Canadian) government already has set aside $40,000,000 for construction and equipment of a plant to make rubber. Extraction of petroleum from McMurray oil sands . . . may lead to the development of a great synthetic rubber manufacturing plant at or near these northern Alberta deposits."

Lead-zinc lodes near Great Slave Lake, just above Alberta's northern boundary, compare favorably with those of the famous Couer D'Alene district in Idaho. Still farther north, on Great Bear lake, are the world's richest radium deposits and silver ore that is seldom exceeded in value anywhere. Alberta's southern coal fields have long produced favorably, and of later years three fourths of the salt used in the province is mined within her boundaries. Copper, nickel, tungsten, tin —all vital today and unquestionably of

value tomorrow—are known to exist in considerable quantities, while the total list of lesser minerals found in Alberta would reach a score or more.

Although no part of the Alcan Highway itself is in Alberta, its southern terminus, at Dawson Creek, just over the border in British Columbia, is reached by a 500-mile standard-gage branch railroad which, in turn, connects with the main line Canadian National and a branch of the Canadian Pacific at Edmonton. The many miles of railroad sidings, the scores of warehouses, the unloading platforms, all Army-built for war-time service at Dawson Creek, will still be there for possible commercial use when peace comes. As present plans do not contemplate extending the highway south of Dawson Creek, the Province of Alberta and the city of Edmonton will play their role in the economic scheme of things to come by providing the connecting rail link between Alaska and the United States.

All photographs courtesy Caterpillar Tractor Co.

Much of the Alcan Highway was constructed through timber. In this stretch tractors and trailbuilders cleared the heavy bush growth; scrapers and graders followed; this stretch of the road is surfaced for all-weather use, with adequate drainage ditches

When a tried and tough Colonel of the Army Engineers said, "Guts and tractors built that road," he must have had in mind, among other sections of the Alcan Highway, the 662-mile stretch from Dawson Creek to Watson Lake, during which it skirts some of the tallest and roughest of the Canadian Rockies and attains to an elevation of 4212 feet, the highest point on the highway. The 366,255 square miles of British Columbia have always been hard and cruel, but the mountains with their severe climate and the milder, more temperate valleys hold much that man considers valuable. Early known for its coastal fisheries and its gold. Canada's westernmost province has been a tough economic nut to crack. However, as the Dominion's chief copper producing state today, with known extensive deposits of lead, coal, zinc, silver, and gold, with huge forests of excellent Douglas fir—all of which will eventually reach the world's markets in greater quantities than at present—British Columbia's economic future needs transportation as much as any other factor to assure her continued progress.

Partially due to topographical features, soils of the province are non-uniform in texture and composition, varying from fertile dark loam and muck to light sandy and gravelly areas. Proper irrigation in the southern interior has produced abundant harvests of fruits, vegetables, and field crops, including alfalfa. In the Peace River Block, sliced by the Alcan Highway, huge virgin agricultural sections that are suited for mixed farming and grain await the plow. The new road to the continent's "upstairs," together with amplification of existing railroad and aviation facilities, will play its part in the commercialization of British Columbia's huge "backyard."

To the fame of "The Spell of the Yukon," builders of the Alcan Highway have added a new lore, no less fascinating than that of the Klondike and its gold rush. Engineers and construction men doubtless agree with Robert W. Service's indictment, "It's the cussedest land that I know." Although for the most part the Yukon is a vast plateau, in the southwest, through which the highway winds, are portions of the Rockies, including 19,850-foot Mt. Logan, highest point in Canada. Because of its far-northern isolation, and with Pacific winds that might otherwise temper the climate cut off by mountains, the long Yukon winters are bitter cold. Brief summers, however, are often actually hot and the almost 24-hour-long days produce fairly good crops of grain and roots in some sections. But it is with minerals, timber, and Alpine-like vistas with unbounded summer recreation possibilities that the Yukon will bid for future economic wealth. There are gold, silver, lead, copper, and coal in the rough and rugged terrain; there are rich forests of spruce and poplar; there are fabulous fish in the lakes and streams, and it is a hunter's paradise which will attract the sportsman, the nature lover, and the vacationist, with the millions of dollars such trade brings to well-organized vacation lands.

Whitehorse, Yukon's principal city, houses about a quarter of the territory's population of 4687. Owing its birth to Klondike days, the town is also the northern terminus of the narrow-gage White

Reminiscent of "Main Street" in any American village prior to the advent of the automobile, the principal thoroughfare of this Alcan Highway town will offer better than mud-hole traction to future truck and bus traffic, and because of economic forces, it may become a busy thoroughfare in a new city of the north country

Pass & Yukon Railroad, also of gold rush fame, which traverses a torturous 111-mile mountain trail to Skagway, Alaska, at the head of the Inside Passage, route of sea-borne commerce to Vancouver, Seattle, and points south. As the junction point of rail and highway transportation to the interior, with a modern airport already in operation prior to the war, Whitehorse may well find itself on the threshold of becoming the future metropolis of the Yukon.

The Alaska-Yukon border is 325 miles west of Whitehorse, via the Alcan Highway, and 100 miles further is Tanana Crossing, where the highway splits, one arm running west to Gulkana and a connecting road to Valdez, on the Gulf of Alaska. The Alcan's other branch rolls on another 100 miles to Big Delta, its northern terminus, 1582 miles from Dawson Creek, where it connects with Alaska's own system of 2366 miles of roadways. Thus, by truck and by rail, are the commercial centers of Anchorage, Seward, Fairbanks, Valdez, and other smaller Alaskan communities joined to Edmonton, in Alberta, to Spokane, to Minneapolis, to Chicago, to New York.

Since 1670 Hudson's Bay Company has been only commercial enterprise in many back-of-behind sections that will now be served by Alcan Highway

Of Alaska's economic future, little need be said, save to recall that its original purchase price of $7,200,000 has been returned thousands of times over by its exports of furs, timber, fish, gold, silver, platinum, copper, coal, and petroleum. Often thought of more as a recreational area than as an economic factor in the life of the nation, Alaska's agricultural possibilities have yet to be plumbed to their depths. Wildlife resources are estimated at $100,000,000; the 1940 salmon pack was valued at $31,000,000; more than $26,000,000 worth of gold was mined in the same year, and other products rank in big figures.

Whether, some day, the "Iron Horse" will join forces with the Alcan Highway, the coastal steamship lines, and the fast-growing aviation industry in linking ever more closely the economic lives of Alaska, the Yukon, British Columbia, and Alberta with the United States is something that must await a future answer. As for "the road that couldn't be built," it is in full war-time operation, providing means of transport for 60,000 to 70,000 tons of cargo per month. Thousands of trucks rolled all winter carrying soldiers and supplies to Alaskan posts, according to Secretary of War Stimson's announcement, and they brought back tons upon tons of strategic raw materials.

First built on an 18- to 24-foot width through a minimum 32-foot clearing, the Alcan Highway will be widened throughout its entire length this summer to a 24-foot graveled roadway. Eventually, the pile trestles which bridge the many streams will be replaced by permanent structures. Then, too, cuts, fills, and grades will be improved from their wartime emergency status to the broader, safer, more conservative construction. When the days of unlimited gasoline and rubber return, we may be sure that not only will the Alcan Highway find its proper commercial niche, but also that it will serve as an unexcelled scenic and recreational jaunt for thousands of travel-hungry Americans.

• • •

MYOPES

Eugenically Speaking, Near-Sighted Persons Shouldn't Mate

Myopia is believed by science to be hereditary. In an address before the American Medical Association, Lawrence T. Post, M.D., St. Louis ophthalmologist, stated that "there is little evidence to show that this is usually anything but a hereditary defect handed down just as other physical characteristics are. Continued stressing of the importance of judicious mating may result in its diminution and finally bring about its end.

"Even if it is impossible to bring about complete eugenic mating, it may at least be feasible to prevent the marriage of two people afflicted with extreme nearsightedness. Failure to do this is probably the principal reason for the very large incidence of this defect among the Germans today."

NYLON SCREENS

Will Replace Many Metal Screens After the War

An entirely new window screen, chemically made, and containing no metal, will be available to American householders after the war. It is made of nylon, now used exclusively for vital military purposes. Having all of the good characteristics of metal screening, and many qualities besides, it can be produced in any color, it will not stain the sills, it will not corrode, it requires no painting, and tests indicate it has extraordinary durability. Pencils or other sharp-pointed objects can be shoved through it without damage; the strength and elasticity of the strands is so great that they come back into place merely by rubbing them with the fingers.

In many cases the new screens will not even have to be put up in the spring and taken down in the fall. They will just be rolled up and down on tracks like a window shade.

The idea of making screens out of nylon occurred to Du Pont chemists and engineers several years ago, at the time the first nylon toothbrushes were being turned out—even before hosiery was introduced. But the new child of Du Pont's creative chemistry, derived from the hydrocarbons of coal, the nitrogen and oxygen of air, the hydrogen of water, made such a sensational hit in hosiery and brushes that the manufacturers were kept busy trying to supply a segment of the demand for those articles. The screens had to wait. Soon, however, our entrance into the war called nylon into service for parachute cloth.

Meanwhile a few screens had been erected at various points for preliminary tests. They stood up well even along the seashore, where salt spray rusts or corrodes metal screens very rapidly. Tests also showed that the nylon screen was so strong and resilient that when something bumps into it no permanent bulge is left

One of the outstanding advantages is the "ingrained" color, which does away with painting. And since there is neither paint, rust, nor corrosion product to peel off or run down the frames and window sills, the staining from these sources is reduced to zero.

• • •

BEDS—The first non-metal beds ordered by the Army in half a century are collapsible and are being manufactured of synthetic-resin-glued hardwood—half a million of them in 15 factories throughout the country.

• • •

SYNTHETIC INSECTICIDES

Food Loss May be Averted by Development

If farms in the United States this summer escape an insect scourge that not only would balk the necessary 30 percent increase in vegetable crops but might well cut our food supply far below normal years, the credit will go to American chemists for their foresight and determination.

For this summer the stage is set for an invasion of bean beetles, pea aphids, cabbage loopers, leaf hoppers, worms, soldier-bugs, and weevils which can devastate far more than the billion dollars' worth of vegetable crops destroyed in normal years. The stage setting consists of a serious shortage of rotenone—the toxic ingredient in imported derris or cubé root—which has held these vegetable destroyers in check for the past dozen years. This crucial war year finds us with less than half of our normal year's supply of this insect-killing ammunition—the rest of it being shut off by Jap battle fleets and German submarines.

The picture would be black were it not for the fact that American chemists had started searching for a synthetic insecticide to equal the effectiveness of natural rotenone long before the war. A group of chemists began research on this problem way back in 1926. For 12 years, in the laboratories of Rohm & Haas Company, they concocted lethal brews for insects, but their efforts received scant attention from growers as long as rotenone

was plentiful. But these chemists continued work till finally, in 1938, they perfected an insecticide promising enough to try out on peas, beans, and other vegetables.

For years growers and agricultural authorities held firmly to the belief that you couldn't kill pea aphids and cabbage loopers, bean beetles and other insects by using insect dusts containing any less than ¼ to 1 percent rotenone. Yet, in 1938, experimenters found that by adding this new laboratory-made insecticide, a thiocyanate known as Lethane, they could get as effective a dust with only half the amount of rotenone normally used in dusts. For example, on the Mexican Bean Beetle, whose taste for beans has carried him to nearly every state where beans grow, the addition of 2 percent Lethane halved the amount of rotenone used

COMPRESSED FOOD
Wrapped in Cellophane, Saves Cargo Space

"NUTRITIONAL ammunition," stamped out in presses to save tons of cargo space and wrapped in cellophane to save steel and tin, is being shipped abroad in vast quantities

Dehydration and compression may be considered as steps taken to get rid of two space-consuming stowaways in ships carrying food abroad to Lend-Lease consumers and to our fighting forces. One stowaway was water, the other air.

Removing the water telescopes, on the average, ten tons of raw food down to one ton, and reduces the space required by 50 to 90 percent, depending on the food product. It also improves keeping qualities and in many cases rules out the need for refrigeration.

Compression squeezes out the second space-robber, air, and saves 35 to 75 percent of the already reduced precious cargo space. Experience indicates that the compression further improves the keeping qualities of the food. By removing most of the air, the opportunity for oxidation, one of the contributing causes of food spoilage, is reduced. Compression also cuts down the food surface area exposed to what little air remains.

The necessity of keeping meats, fruits, vegetables, eggs, and other foods in good condition during the long and difficult trip from an American farm to an Allied or American battlefront imposes important responsibilities not only upon the method of preparation but upon the packaging. Some of the foods are consigned to Arctic regions. Others are headed for the humid tropics where mildew, insects, and heat make it difficult to keep food even in normal times. During the war some of the food cases may stand on wet beaches, exposed to the sun and surf, until busy soldiers can move them to a better place.

Because of the shortage of tin and steel, cans are available for only a portion of the food being exported. Therefore technical men of the Du Pont Company's Cellophane Division began studies some time ago looking toward the replacement of metal by this thin transparent film and various laminations of it. Severe tests confirmed the value of cellophane as a moisture-vapor-proof, dust-proof, and germ-proof protective covering for foods, either alone or in laminated form with other materials. As a result of these tests cellophane in its various forms is highly regarded by various government agencies for the packaging of dehydrated food for Lend-Lease and Army use.

In the compression process as developed by the inventor, John C. Donnelly of the Auto Ordnance Co., each type of food is considered as an individual problem, and the temperature and pressure employed adjusted to fit particular requirements Some of the dehydrated food is quick frozen at temperatures from 20 above to 20 below zero, Fahrenheit, and held at low temperatures during compression to keep the fat globules from breaking down. Pressures employed range from 250 to 2500 pounds per square inch. The aim in all cases is to compress the food without destroying its caloric or vitamin values

The food can be compressed at the rate of 170 cakes a minute, in some instances As soon as each cake is formed by the press it goes into a cellophane wrapping machine, which keeps pace with the press The touch of a heated sealing bar on the cellophane wrapper seals the contents from air and moisture.

Cost of the process, it is pointed out, is no more than packaging the same food in tin cans. In fact, in many cases it is less. Compressed foods now include potatoes, carrots, cabbage, onions, soy bean flour, apples, soup mix, eggs, beets, and cabbage soup. Some of the products are compressed into cakes slightly larger than a yeast cake. Others are put up in one-pound units. A package no larger than a small shoe box contains enough compressed potatoes to serve 100 men.

Eggs, because of their high nutritive value, have been an important Lend-Lease and Army item. Dried, they take up only a sixth as much space as in the shell, and when compressed the bulk is further reduced by half. A 14-pound package of compressed dehydrated eggs contains the equivalent of 537 fresh ones. Expressed in another way, a dozen eggs, dried and compressed, ride in approximately the cargo space that is needed for only one egg in the shell.

CONTAINER CLOSURE
Makes Possible Re-Use of Glass Jars

Millions of "thrifty lids" will be available this season to assist the housewife in putting up fruits and vegetables at home. The thrifty lid, a war-time closure device which makes possible the re-use of commercial glass containers for preserving foods at home, was developed by The Owens-Illinois Glass Company. The successful distribution of millions of thrifty


Vacuum caps for jar re-use

lids last year has resulted in the release of sufficient metal this year to further assist the American housewife with her home preserving.

The thrifty lid was originally developed to fit the 63mm. opening of glass coffee containers. It may be used on any commercial glass container having the same size opening, with the aid of the original metal screw cap that comes with the jar.

Since metal screw caps for glass coffee are gradually being replaced with paper caps, housewives are advised to save metal caps along with coffee containers and other jars she is holding for household use.

The thrifty lid itself is a thin, composition-lined metal disk which may be purchased singly or in quantities of a dozen. It is used in combination with the metal screw cap that came on the jar originally. The first step is to scrape all of the composition lining out of the inside of this original metal screw cap. It is very important to remove this completely, since any remaining lining may adhere to the top of the thrifty lid during processing.

From then on regular preserving methods are followed. The jars are filled with the food to be processed, the thrifty lid is placed on the neck of the jar and the original cap is screwed over it to hold it in place. After processing, when the jars have cooled, the screw cap may be removed and used over again. The thrifty lid is held in place by vacuum, and, of course, may be used only once.

THIRD DIMENSION
Effect Obtained With Conventional Movie Camera

An entirely new principle for the projection of third dimensional moving pictures has been developed by Everett H. Bickley, of Philadelphia. Through the use of a "swing mount" it is possible to obtain the illusion of depth in a projected moving picture without the use of special cameras, films, projectors, or screens.

As our photographs show, the camera is mounted on one end of a set of movable arms, another end being attached to the tripod. The design of the arms is such that the camera is rigidly held against vibration yet can be swung freely from side to side.

In taking the picture, the scene is composed in the finder and the exposure is made in the usual way except that the camera is swung very slowly back and forth during the taking of the picture. Speed of the swing is about eight seconds in each direction.

The resulting third dimensional effect is obtained because, while the camera swings on the arms, it is kept pointed at the principal object by means of an auxiliary arm which keeps the lens correctly aimed throughout the swing. Since the


Focusing the swing mount


Focusing the swing mount

lens steadily and continuously aims at the point of principal focus, through adjustment of one of the arms, all blur is avoided, the interest is not distracted by the swing of the camera, and the appearance of third dimension is created by the movement of the foreground and the background.

• • •

NETS—Fishermen in west coast waters are now using purse-seine floats made of glass instead of cork. These floats are enclosed by woven rope pockets which protect against smashing and breakage, are more durable, and last longer than cork.

• • •

CHEMURGIC RUBBER
Made from a Base of Vegetable Oils

Commercial production of a new synthetic rubber, using a base of domestic vegetable oils not considered suitable for edible purposes, has been under way for several months, it was announced recently by Dr. N. E. Van Stone, vice president of the Sherwin-Williams Co., in charge of operations. Called "KemPol," the vegetable-oil rubber substitute is a development of the Sherwin-Williams research laboratory's work with "drying oils" used in paint manufacture.

Unlike most chemurgic rubbers, KemPol requires no critical equipment for its manufacture and the volume of production will be limited only by the amount of oil available for the purpose.

Tensile strength, elongation, and abrasion resistance of KemPol are not on a par with those of natural rubber, although in many other properties it compares so favorably with natural rubber as to enable its use in many products such as treads, mats, pads, erasers, gaskets, braided hose, and so on. Since no toxic raw materials are used in the manufacture of KemPol, it may be used for such other work as jar rings and various types of seals for food containers.

KemPol lends itself readily to emulsification and—with certain limitations—to solutions, so that a number of successful applications in the fields of fabric coating, tapes, adhesives, and sealing compounds have resulted. KemPol sponges easily, offering many possibilities in that field.

KemPol also shows considerable promise as an extender for natural reclaimed, and the Buna and Butyl rubbers, with all

of which it is readily compatible. The customary fillers, extenders, and accelerators have been found to work well with KemPol and standard rubber making equipment, as found in the average rubber plant, is entirely adequate for the purpose.

Tensile strength of the new "rubber" is 300-500 pounds per square inch, and elongation is 100-150 percent. After aging 72 hours at 170 degrees, Fahrenheit, tensile strength increases about 100 percent and elongation decreases about 33 percent.

ROOFING
Shingles Held in Place by "Spot Welding"

VARIOUS types of roofing materials — roll roofing, strip shingles, and so on— can be applied with the use of a minimum number of nails through the application of a "spot welding" system developed by Paraffine Companies, Inc.

Roofing applied by this method is held in place with about 50 percent of the usual number of nails, while a cementing material, Hydroseal, is applied in spots between layers. These spots of adhesive, it is claimed, hold the roofing securely against the force of a 50 mile an hour wind.

POST-WAR TRANSPORTATION
Highway Vehicles Will be Improved in Many Ways

MANY developments of the war production period can undoubtedly be applied to peacetime vehicles with beneficial results, if industry is given a free hand. This was recently emphasized by Robert F. Black, President of The White Motor Company, when reviewing technological changes and developments in the design and use of motor transportation units.

Speaking of engineering possibilities, Mr. Black said that "when the war stopped production, it pigeon-holed many improvements which had been recently developed or were still under development. It is unlikely," he opined, "that the first commercial vehicles to be produced immediately after the war will differ radically in general design from those in production last year. The immediate need in all probability will be too great to allow quick and drastic redesign.

"Yet, just as World War I was the cradle in which the motor truck was nurtured, so World War II can easily be responsible for evolution of entirely new departures in vehicle design. Large scale production of motor trucks for the armed services can easily mean, for instance, that designs which have not had much popularity among operators in the past, may by their performance stir a general commercial demand.

"It appears inevitable that a trend toward higher horsepower in truck engines should set in. The war has brought in large scale production of 100-octane gasoline for airplanes. One would expect increase in engine compression ratios to take advantage of the higher anti-knock qualities of the new fuels. Within the realm of possibility is introduction of super-chargers on truck engines.

"It is anticipated in the industry that there will be a continuing demand for more and more automatic and semi-automatic operation of transmissions in heavier trucks and busses. It is the further view of many engineering minds that there will be a marked increase in the output of trucks with front as well as rear driving axles. Rapid strides have been made in recent years with this type of vehicle in its development for the all-purpose needs of the Army.

"Experience being gained in the current conflict will lead the way for reducing net weights of the vehicles so as to increase the payload to be carried and thereby decrease the cost of the transportation. Unquestionably there will be further improvement of the safety features of the vehicles due to research that was on the way before the war, as well as experience now being gained.

"The industry is watching closely the advances that are applied to aviation to see what can be adopted for the motor truck and bus, just as motor vehicle developments have been applied in aircraft development and even, in recent years, by the railroads."

While offering these future possibilities, Mr. Black said that no experienced truck man would undertake to chart out a definite evolutionary pattern for the years ahead. The reasons, he said, are found in the factors which have shaped truck, bus, and trailer history to date.

"In other words, the motor vehicle is limited by the highway systems and the terrain traversed; motor vehicle development is affected profoundly for good or bad, by restrictions and regulations; the engineering of engines and vehicles is fluid and subject to changes of very great proportions; and, most important of all, the positive force in the development and improvement of truck, bus, or trailer is the one created by the ideas and wants

of tens of thousands of people all over the country, each with a job to do, and each wanting a vehicle that can handle it. Commercial vehicles must adapt themselves to the load rather than the other way around."

PACKAGED COFFEE
Enough for Two Cups in Aluminum Foil Packet

COFFEE now goes to the front in snug, feather-weight packets, each containing sufficient coffee concentrate for two generous cups. Standard equipment in ration K, these packages are made of aluminum

Aluminum foil protects coffee

foil one thousandth of an inch in thickness and coated on one side with a thin film of a thermal plastic for hermetically heat-sealing all four edges.

This type of packet is impervious to light and moisture and is resistant to the effects of either the intense heat of the tropics or the extreme cold of the far north. The aluminum foil gives the packet ample strength and effectively shuts out light, while the plastic coatings, both inside and out, serve their respective purpose of heat-sealing the packet, strengthening and protecting it against rough handling. The powdered coffee in a single package weighs barely five grams, and the filled capsule weighs only six grams. An equivalent amount of coffee of a normal grind weighs twenty-five grams, not counting the weight of the container

Results obtained in the field are highly satisfactory. Soldiers report that the capsules are easy to handle and the coffee simple to prepare. Where a fire is not available, the powder may be mixed with cold water.

HEALTH EXPERTS
Will be in Greatest Post-War Demand

HEALTH, foundation of the nation, will demand the most trained experts after the war, according to E. E. Crabb, president of Investors Syndicate, in a report on predictions of 346 American colleges, technical schools, and universities.

"Nearly one of every three predictions by American educators on post-war demands for trained experts, perhaps reflecting the maxim, 'health alone is victory,' forecasts health or allied activities," continued Mr. Crabb. "Over a fifth of the replies mentioned business or associated fields. Natural sciences received 18.4 percent, other professions 13.2 percent, social work 6.4 percent, miscellaneous experts 3.6 percent, and government specialists 3.4 percent of the total.

"Ten occupations accounted for 72.36 percent of the total mentions in the list of 65 specific types of experts. The number of times such experts were mentioned and their percentages to the total follow: doctors 118, or 11.6 percent; engineers 104, or 10.2 percent; foreign trade specialists 99, or 9.7 percent; teachers 98, or 9.7 percent; nutritionists and social workers each 54, or 5.3 percent; occupational therapists 46, or 4.5 percent; dentists 37, or 3.5 percent; economists 33, or 3.2 percent; and business administrators 31, or 3 percent."

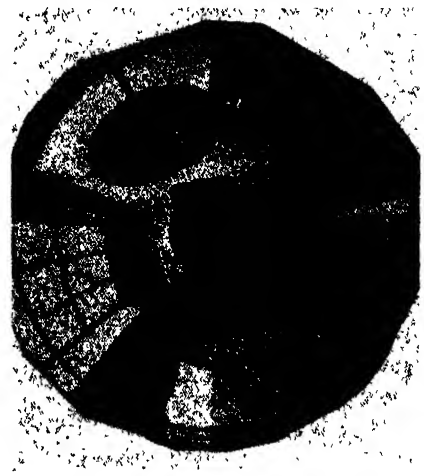
"What trained experts will be most in demand after the war?" the nation's higher educational institutions were asked Three hundred and forty-six schools—261 co-educational, 54 women's, and 31 men's —replied, many of them mentioning more than one type of experts in their aggregate of 1071 mentions.

Doctors led the list in both co-educational and men's colleges. Teachers headed the list in women's schools Engineers came second in both co-educational and men's universities, while nutritionists held that place in women's institutions. Foreign trade ranked third in both co-educational and men's faculties, though sixth in women's colleges. Medical technologists took third place in schools exclusively for women

"FISH-EYE" CAMERA
Aids in Study of Lighting Problems

PHOTOGRAPHS made with a "fish-eye" camera, which show everything in a room above its own level, enable engineers to solve quickly problems of illumination which would otherwise require elaborate and lengthy calculations. This "illuminagraphic camera," it is stated, will be specially valuable for studying the illumina-

Set-up of the "fish-eye" camera



A picture made with the "fish-eye"

tion in airplane and other war factories, built without windows and lighted with large areas of fluorescent lamps.

In an experimental model, a camera of customary type is mounted on an iron stand, and pointed toward a curved mirror. The curve of this mirror has to be adjusted very accurately. The result is that a photograph taken of the reflection shows the area of extended light sources, such as a window which shows the sky, or a bank of fluorescent lamps, in exact proportion to the amount of light which a surface at the location of the mirror receives from the light source.

Even if the area from which the illumination comes is irregular, it can be measured easily on the photographs with an instrument called a planimeter. When the brightness of the source is known, the actual illumination at the mirror can be determined.

Both the camera itself and the support are visible in the picture, but they take up a small area, and ordinarily would not affect the result. It is not necessary that the mirror be horizontal. It can, for example, be placed at an angle, as to measure the illumination of a sloping drawing board. By determining the amount of light received from a window, and between its various parts, such as the upper and lower sashes, the most efficient lighting may be planned

• • •

WOODLOTS—Well-managed farm woodlands in the Lake States are capable of yielding annual returns of $5 or more per acre, as compared with present average returns of less than $3 per acre, according to the United States Department of Agriculture.

• • •

ENGINE MOUNTING
Insulates Vibration, Uses Less Rubber

AN INSULATED engine mounting that reduces the amount of steel and rubber required by 17 percent and can be had in almost any combination of metals and rubber, or synthetics, to suit individual requirements, is used primarily to insulate vibration, absorb shock, and com-

pensate for misalignment in heavy-duty equipment.

The design of the mounting and the principle of assembling the rubber wall between an inner and outer wall of metal are relatively new to the United States, the assembly being held together by a mechanical rather than chemical bond. Thus the members are held together with the elasticity of the live rubber which forms the insulating medium as well as the bonding member. This mechanical bond not only permits the reduction in the amount of rubber employed (the mechanical type of bond being considerably more efficient) but also allows the use of synthetics or "full reclaim rubber" instead of pure rubber.

Loads that are far in excess of the rated capacity of the mounting must first equal the shear strength of the rubber be-

Failure-proof engine mounting

fore the bond will "slip." Even should this occur, the engine would still remain operative, as the amount of "fall" would not exceed one-fourth of an inch and the support mounting would merely change from an "insulated" to a "solid" type of support.

CIRRHOSIS

It Now Isn't the Alcohol But Remains Alcohol-linked

THE BELIEF that cirrhosis of the liver is caused by the toxic effect of alcohol or of toxic substances present in alcoholic liquors is giving way to the conviction that dietary deficiencies often associated with chronic alcoholism are, more probably, the factors responsible, according to the review of scientific literature in *Nutrition Reviews* (New York).

The new concept derives support from two different sources: animal experiments in which cirrhosis has been produced by deficient diets, and therapeutic studies which suggest that high protein diets and administration of the vitamin B-complex, and in particular choline, favorably influence the course of some patients with hepatic cirrhosis.

Evidence from experiments on laboratory animals indicates that liver damage and cirrhosis may result from deficiencies

of the vitamin B-complex, or of protein. For instance, cirrhosis has been produced in rabbits on diets which lacked yeast. Rats fed rations deficient in the vitamin B-complex develop fatty degeneration and necrosis of the liver; they can be protected from this degenerative change if the B-vitamins are supplied. Dogs fed diets low in protein, deficient at least evidence of hepatic damage which can be corrected if the deficiency is eliminated.

Much recent investigative interest has centered about the importance of protein and some of the amino acids in hepatic physiology. The general plan of these studies has been to feed rats synthetic diets low in protein, deficient at least in some members of the vitamin B-complex, and containing varied amounts of carbohydrate and fat. A large percentage of the animals subjected to this regime developed fatty infiltration of the liver, necrosis of hepatic cells which usually begins in the central or midzonal areas of the liver lobule, and periportal cirrhosis. Hemorrhage frequently accompanies the necrosis. These changes have been prevented in whole or in part by feeding choline, brewers' yeast, a combination of crystalline thiamine, riboflavin, pyridoxine, pantothenic acid, and choline.

• • •

NIGHT SIGHT—Just as night fliers are selected by special eye tests for ability to see in the dark, so employes in photo-film plants are chosen, since they must work without illumination to produce modern super-sensitive films. At some plants a "change room" is provided where men finishing work can slowly adjust their eyes to daylight brightness.

• • •

VIRUS KILLER
Found in the Ultra-Violet Ray

THE DISEASE-CARRYING virus, spreader of wartime epidemics, has an "Achilles heel" that makes it vulnerable to ultra-violet rays and consequent destruction, according to Dr. Harvey C. Rentschler, director of research at the Westinghouse Lamp Division. Experiments with these tiny particles of chemical substance have indicated, he says, that "bullets of ultra-violet light" must strike a certain spot in the virus before it is "killed" or injured, but when such accurate shots are made, it means certain annihilation for the disease carrier.

"This ability of ultra-violet to inactivate virus means that science now has an effective weapon to use in the battles against influenza, infantile paralysis, and the common cold, among other diseases thought to be caused by virus," he declares.

Dr. Rentschler, under whose direction the germ-killing Sterilamp was developed for practical application, has conducted thousands of tests to determine the exact amount of ultra-violet radiation required to inactivate virus in various quantities and conditions.

"We have known that air-borne bacteria can be completely destroyed when subjected to enough radiation at the correct wave length," he explains, "but our experiments with bacteriophage, a type of virus, have produced curious results.

"We found in one experiment, for example, that six arbitrary units of ultra-violet radiation will inactivate 50 percent of the bacteriophage sample and that 12 units will destroy 75 percent. When we applied 400 units, better than 99.9 percent of the virus particles were inactivated.

Exposing viruses to ultra-violet

We have yet to achieve 100 percent destruction consistently, however, since even such a heavy barrage of ultra-violet rays apparently misses the 'Achilles heel' of a few virus particles.

"Bacteriophage particles and probably other viruses seem to be destroyed when a photon of ultra-violet light of the proper energy hits the proper band in the molecule," states Dr. Rentschler. "In the case of bacteria, on the other hand, our tests have shown that the killing action is caused by the accumulated energy of the different photons.

"In other words, photons, which might be called 'bullets of light,' must strike a vital spot on the virus molecule or else the virus is unharmed. When bacteria are struck at any point, however, they receive either a partial or fatal injury."

The viruses, which many believe to be merely chemical compounds and not living organisms like bacteria, have been found to be a widespread cause of disease in man, animals, plants, and insects, Dr. Rentschler points out. They are so small that they pass through all filters and can be seen only for a moment in outline by the powerful electron microscope.

RIBBON RENEWER
For Typewriters, Lengthens Life, Is Inexpensive

WITH a simple little device, and the necessary chemical fluid, it is now possible to lengthen the useful life of office machine ribbons at a reported cost of 1½ cents each.

The manufacturer of the device claims that the average typewriter ribbon can give three to five times the normal service if it is given a periodic treatment with the chemical, which restores the original brilliance and keeps the ribbon soft and pliable, thereby preventing wear.

The reviving is done by merely rewinding the ribbon through a simple applicator device which is filled with the fluid. It is not necessary to remove the ribbon from the typewriter.

• • •

SALVAGE—Mexico plans to salvage a sunken gunboat, the *Vera Cruz*, to help provide scrap for her growing steel production. According to a Mexican radio broadcast, the gunboat was sunk by its own crew in 1914 to prevent it from falling into the hands of revolutionists.

• • •

FIRE BLANKET
Designed to Extinguish Flaming Clothing

FOR USE in war industries and by air raid wardens, first-aid stations, and so on, a new heat-resistant flameproof blanket has been recently made available. This blanket is contained in a convenient casing which may be hung on the wall or carried in the hand and from which the blanket can be instantly removed. In case of fire, the blanket is pulled out of the case and thrown around burning clothing.

SUNLIGHT RECORDS
Made by Use of Self-Operating Device

AT THE Ohio State University's green houses, where sunlight data are important in the study of soilless horticulture, constant records are made by the use of a detector consisting of either a photoelectric cell or an Eppley pyrheliometer. The detector is exposed on the small platform shown in the accompanying photograph, just outside the greenhouse, and is connected by leads to a Micromax recorder, located in a laboratory some distance away.

Detector of sunlight

Except for minor attachments, the Micromax is exactly like those generally used for recording of temperature. It is a self-balancing potentiometer, hence is unaffected by changes in the resistance of the leadwires. It has no calibrated

springs; no helixes; no jewelled bearings. It is self-standardizing, driven by an electric motor, and holds ample supplies of ink and chart, hence operates for days or even weeks with no attention, thus freeing its user for other work.

IMPACT SWITCH

Acts to Prevent Fire in Plane Crashes

ANOTHER in the long list of safety devices developed for United States Army and Navy planes is an ingenious "impact switch" which automatically discharges several pounds of liquid carbon dioxide into the engine compartment when a combat plane crashes. The device, developed by engineers of Walter Kidde & Company, functions as an automatic fireman to release clouds of fire-killing vapor into an engine compartment even though the pilot is unconscious or rendered incapable of quick action. The switch contains a trigger device which can be set to go off under a force greater than any encountered during the sharp dives and twists of aerial dog fighting or rough landings on bumpy fields.

Switch that prevents crash fires

GASKET

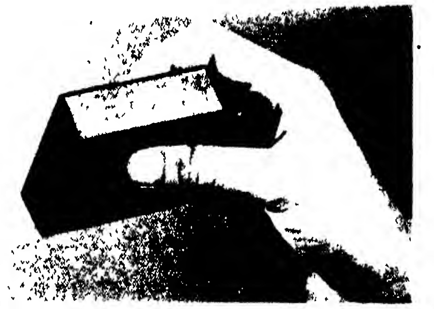
Combines Sponge Rubber and a Synthetic

SPONGE rubber gaskets covered with a smooth coating of natural rubber or Ameripol synthetic rubber by the extrusion process are now being used in products of war, mainly airplanes and tanks, where they are proving their value as a sealing member in severe service. After the war, this new type gasket is expected to find wide use on refrigerators, automobiles, and other products.

When made with a covering of Ameripol, the synthetic rubber developed by B. F. Goodrich, the new gasket withstands the destructive action of oils and greases which have so often spelled destruction to refrigerator door gaskets made of natural rubber. The ability of this synthetic

rubber to withstand extremely low temperatures also will make the new development especially valuable in the refrigeration industry. The gasket has a much lower permanent set than the tubular type heretofore used on refrigerators and automobiles, and is as soft and compresses as well as the older type.

In the new process, the sponge rubber filler used is molded in slab form, slit



Section of new extruded gasket

into strips, and fed through a special extruding machine to obtain the smooth covering which varies in thickness according to specifications.

• • •

TOOL EXPANSION—A fine machine tool cannot turn out the same size article during a cool midnight shift as during a hot noon shift, unless the temperature at the machine is the same. Heat expands the tool and may vary the size of the part enough to disrupt a final assembly line completely.

• • •

VITAMINEWS

Make Room for More Vitamins—
They're Being Discovered

THE LATEST tally on the number of B vitamins shows that there are at least a dozen separate compounds in this group, the vitamin B-complex. Evidence for the existence of seven relatively new members of the group, and what they are likely to mean in terms of human nutrition and control of still unconquered diseases, was presented by Prof. C. A. Elvehjem, of the University of Wisconsin, at a recent meeting of the Society of Sigma Xi.

Biochemists and nutritionists now speak of six B vitamins with considerable familiarity, Prof. Elvehjem said. These six are thiamine, riboflavin, nicotinic acid, pantothenic acid, pyridoxine, and choline

Experiments by many scientists as well as those of Prof. Elvehjem and his staff have recently demonstrated vitamin-like activities for biotin, which is now available in pure form; inositol and p-aminobenzoic acid, two known chemical compounds; folic acid, which is being studied extensively as a growth factor for bacteria; two chemically unknown factors needed by the chick for growth and for feather production; and one or more factors of significance in guinea pig nutrition.

Rather definite evidence is available to show that biotin is of importance in human nutrition, Prof. Elvehjem said. Little can be said about inositol in human nutrition.

The fact that a number of animals do require this compound makes it necessary to at least consider its possible essential nature in humans. p-Aminobenzoic acid can undoubtedly produce certain effects in the human.

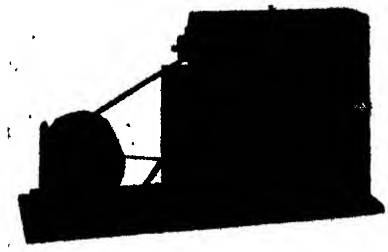
Indirect evidence, including studies on man's close relative, the monkey, suggests that folic acid may also have significance in human nutrition.

VACUUM PUMPS

Employ Bellows Driven by Electric Motors

A POSITIVE-TYPE vacuum pump for production and laboratory application is available in two standard sizes, supplied with individual electric-motor drives, or without motors for use with an available power source.

The pump employs four bellows mounted within a square wood frame, connected to each other and to the pump



Smooth running, low maintenance

outlet by a channel running through the frame Bellows, which are successively expanded to exhaust air or gas from the equipment to which the pump is connected, are driven by a revolving shaft through connecting straps. The shaft is V-belt driven at a relatively slow speed, approximately 200 revolutions per minute, contributing to a smooth running unit and low maintenance

Flexible sides of the bellows are made of leather, as are intake and exhaust valves All joints are gasketed by neoprene cloth, and the frame or case has a black wrinkle finish. The larger of the two units is rated at 15 cubic feet displacement at four inches of mercury. Bellows are six inches wide, and pumps individually driven use a ½-horsepower motor. The smaller unit, rated at seven cubic feet displacement at four inches of mercury, has four-inch bellows and uses a 1/6-horsepower motor. The pumps, made by American Automatic Typewriter Company, are equipped with governors to vary their capacities, and to prevent excessive wear on pump parts, the power transmission unit, or the motor when air or gas has been exhausted to the capacity of the pump.

WELDING GLASSES

Permit Better View of the Operation

AN EYE-PROTECTION glass which permits eyes of gas welders to pierce blinding glare and see welding operations from

beginning to end was announced recently by Dr. E. D. Tillyer, research director of the American Optical Company, who said that the new glass is expected to increase the production of welded battle equipment for the Army and Navy.

Previously, he stated, the glare of flame-welding made it impossible for welders to see exactly what they were doing—a factor slowing the welding of planes, tanks, ships, and other military equipment.

Welders can now see their work

Lenses made from the new glass, it is reported, now let a welder look through the cloudy yellow flames of burning sodium vapors and see clearly the welding rod and the molten area.

"This greater vision," Dr. Tillyer, declared, "not only helps speed a welder's production, but the glass also protects his eyes by absorbing dangerous invisible ultra-violet and infra-red rays generated during the welding operation."

Dr. Tillyer disclosed that the new glass was developed by adding didymium, a rare metal, to the composition of a standard welding glass, the result being a distinctively new glass with exceptional ray-absorbing properties in the visible and invisible portions of the spectrum.

• • •

GLYCERIN—Nitroglycerin is so critically needed for bombs and torpedoes, for dynamite used in mining metal ores and coal, for building military installations, and other war work that the government now permits soap manufacture only when glycerin is recovered.

• • •

ANCIENT NEW MEXICANS
Lived a Simple Life, as Revealed by Research

PREHISTORIC Americans who lived in western New Mexico during a period dating from a thousand or so years before the Christian era to about A.D. 700 suffered physically from malnutrition due to inadequate diet. Mentally they tended to be isolationists. These conclusions are reached in research conducted into evidence regarding their lives, unearthed by Dr. Paul S. Martin, chief curator of anthropology at Field Museum of Natural History, and associated archeologists. The results are published in a book issued by Field Museum Press—"The SU Site—Excavations at a Mogollon Village." The research was conducted over several years by the Field Museum Archeological Expeditions to the Southwest, led by Dr. Martin.

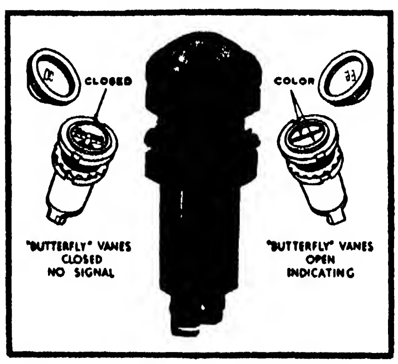
The SU site, where ancient ruins of several villages were excavated, is located in a canyon of the Apache National Forest. The people whose history was studied are an extinct Indian tribe known as the Mogollones. The extensive collections resulting from the excavations, including pottery, remains of old house types, human and animal burials, implements, and various other kinds of artifacts have been subjected to intensive investigation at the museum, and to comparisons with similar material collected from sites representing other prehistoric cultures of this and nearby regions, some related to the Mogollon, and some distinct.

Mogollon culture was an undeveloped, unsophisticated, unalloyed, unvarnished, homespun kind of culture with no striking or dramatic features. The general Mogollon cultural pattern was unadorned and lowly and based on almost minimal requirements. It was homogeneous, non-expansive in that it probably sought no, or few, contacts with other cultures. When Pueblo Indian influences drifted into the Mogollon area, the resistance of the Mogollon culture was so mild that the Pueblo culture became the dominant one.

The people of the SU site hunted little . . . projectile points are scarce. . . . Fishing was probably not carried on, for no fish bones were found. Agriculture, too, was probably unimportant in their economy. . . . It seems safe to assume they lived mostly on seeds, roots, berries, nuts, insects.

INDICATOR SIGNAL
Uses Fluorescence Instead of a Small Lamp

WORKING under "black light" from the usual sources within aircraft, a new indicator signal includes a fluorescent unit which gives a positive indication whenever the "butterfly" vanes which cover it are opened. Operation of these shutters is by means of a built-in solenoid which opens the vanes instantly to show signals. When not indicating, the Signalette unit, as the indicator is called, is black. Current consumption is only about 1.5 watts.



Indicator and the vane action

Latest Helicopter

Is a Two-Seater with Enclosed Cockpit; Will Assist in Allied Convoy Protection Against Subs

ALEXANDER KLEMIN

**Aviation Editor, Scientific American
Research Professor, Daniel Guggenheim
School of Aeronautics, New York University**

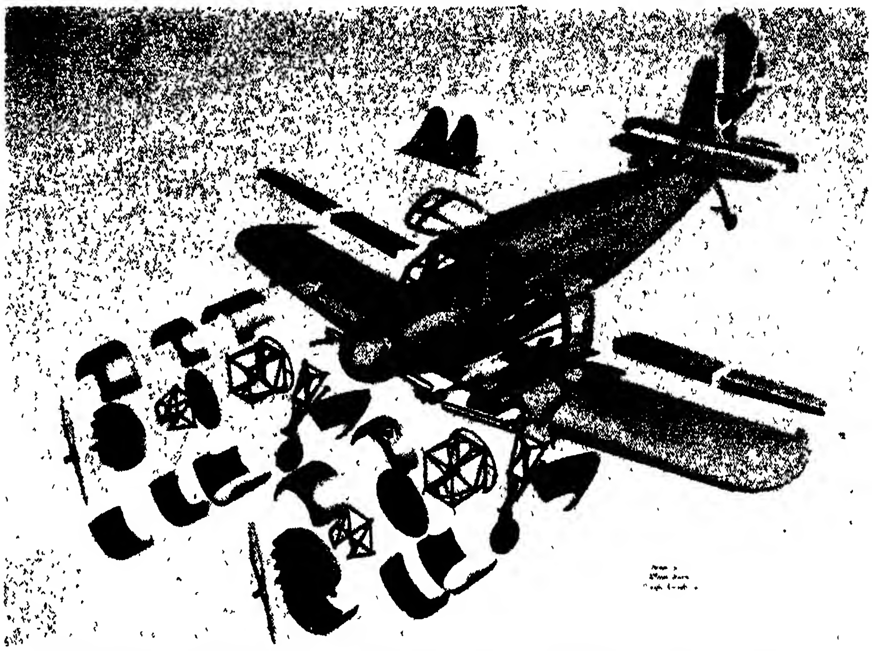
It is good news for the helicopter advocates and still better news for our anti-submarine command, that the British have ordered 250 of these aircraft to serve in convoy protection across the ocean. Perhaps our readers will remember that a suggestion for this use of helicopters and autogiros was made by W. Wallace Kellett several years ago, and since then others have made similar suggestions to which naval authorities have finally given practical approval. This makes it all the more desirable that full encouragement be given to the helicopter, for which each day brings the possibility of greater uses. The Army has immediate and realistic motive in fostering the craft. For example, it can be used for liaison and message carrying behind the combat lines. A telephone line, dropped from the craft to the ground, would make possible the delivery of messages in inaccessible spots The helicopter might also be used as an aerial ambulance equipped with litters, particularly in jungle areas.

One of our photographs shows the latest embodiment of the Sikorsky helicopter, in which the nose is somewhat blunter than in the previous models, and the pilot's cockpit is fully enclosed. The main rotor is now 36 feet long and the small vertical airscrew at the tail takes up the torque, gives directional control, and is seven and one-half feet in diameter. The helicopter weighs 2400 pounds and is about 38 feet long. There are seats for the pilot and one passenger. The seven-cylinder Warner radial engine provides the power The delivery flight of the first United States Army helicopter from the Sikorsky plant to Wright Field covered five days, actually consisted of 16 different flights, and established an individual flight distance record of 92 airline miles. A record speed of 82 miles per hour and a climb to 5000 feet were also made by this machine. The pilot, C. L. Morris, reported that in spite of the most bumpy weather the ship behaved beautifully and showed excellent stability and control. Altogether, the helicopter situation at the present time may be regarded as highly promising.

"EXPLODED" SKETCH Enables Mechanics to Grasp Fundamentals

One of our illustrations shows a type of airplane drawing which is rapidly becoming popular and proving of value in training mechanics for assembly, maintenance, and repair work. Such drawings have the advantage of giving a new man

Demonstrating the maneuverability of the helicopter



Mechanics in training learn readily from such "exploded" sketches as this one

an immediate perception of the main sub-assemblies of the airplane and of their relationships to one another. Shown in our photograph is one of the Cessna AT-17 "Bobcats," an advanced trainer. It is remarkable how quickly new mechanics can follow and learn from this type of drawing A glance shows the four upper parts of the cowling on either side of the engine nacelles, and likewise the four lower parts. The nacelle is evidently constructed throughout of welded tubes with a mounting ring for the motor itself There is an inner flap and an outer aileron on the wing.—*A K*

COLD TUNNEL
Has High Power for
Aerodynamical Testing

A NEW wind tunnel, being assembled by the engineers of the York Ice Machinery Corporation for installation at the Army Air Forces Experimental Station at Wright Field, will be 600 feet long and built in the shape of a huge "O". A 40,000 horsepower motor will circulate the air at 600 miles an hour and at pressures and altitudes corresponding to flight at altitudes of 40,000 feet.

As the wind travels around the first turn in the tunnel, it will pass over a network of cooling coils chilled by as much as the equivalent of 8000 tons of ice refrigeration. The temperature of the cooling coils will be 70 degrees below zero, Fahrenheit, while decompression pumps will reduce the pressure in the tunnel to only 2.7 pounds per square inch. As the air expands from the wide section of the tunnel to the narrow working section at the throat, the expansion will further reduce the air temperature until it drops to 67 degrees below zero.

In making a test, engineers will place models in the tunnel's throat and close an airtight door and watch effects through observation holes after high altitude conditions have become established.

To cool the giant motor which drives two 40-foot fans, each with 16 blades, more than 85,000 feet of filtered air a minute will be required.

To prepare the tunnel for each test, tons of calcium chloride solution will have to be cooled and stored in tanks up to a period of 20 hours, and the motors driving the refrigerating compressor will themselves have a total of 2250 horsepower

The importance of the problems which it will be possible to investigate in the tunnel can scarcely be over-emphasized Ice formation at high altitudes, while better understood, has not yet been completely conquered, and here will be a ready weapon. The behavior of wings, engines, nacelles, and other aircraft parts under these abnormal atmospheric conditions will be studied not only from the point of view of ice formation, but from the standpoint of compressibility effect which may tend to increase their drag to a considerable extent.

While refrigerated wind tunnels have been previously available at Langley Field and in the laboratories of the Goodrich Company, they have been relatively small and of slow air speed. The new tunnel will improve experimental facilities tremendously.—*A. K.*

BICYCLE LAMPS
Used On Cargo-
Carrying Parachutes

THE tail-light formerly made for bicycles has proved adaptable for use with parachutes. Now to each cargo parachute a lamp and a small dry cell are fastened to make it easier for paratroopers to locate supplies dropped to them at night. The same lamp and battery combination are also fastened to life preservers to make it easier to see the swimmer, and to make it easier for him to know where he is going. Westinghouse is responsible for this useful adaptation of another peacetime product to military needs.—*A. K.*

New Products

PLANT SWEEPER

A mechanized floor sweeper which cleans at the rate of 16,000 square feet per hour has recently been announced by the Moto-Mower Company. Operated by one man or woman, this model provides a whole sweeping department for the average size plant.

16,000 square feet per hour

The mechanized sweeper, replacing the old-fashioned broom, releases men to do other work around the shop. Our illustration shows the Detroit model Moto-Sweeper being used in and around machinery in a tool, dye, and fixture shop where heavy metal machinings are as readily picked up as are the lighter dirt and dust.

QUICK-DRYING OIL

A dry film that is quickly formed and which is both hard and tough can now be obtained through the use of a processed linseed oil designed for use in the manufacture of paint, enamel, and varnish. Designated by the manufacturer, National Lead Company, as 710 Oil, it is available in three types for differing processes. Paints compounded with the material are stated to be rapid drying, to adhere well, and to be of good gloss.

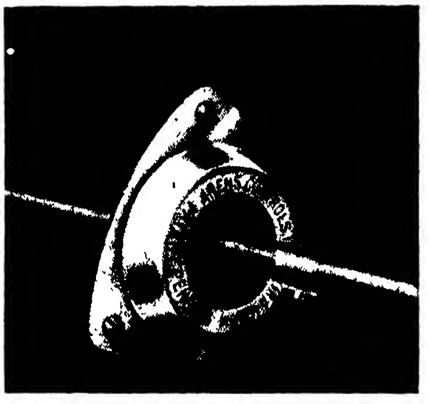
LINE SUPPORT

A fume- and water-tight support for air, oil, and hydraulic lines, electrical cables, flexible remote control casings, and so on, through a firewall or bulkhead, is provided by Dura-Grom, recently announced. It eliminates many quick disconnect and firewall fittings, and slips over a line, cable, or tube to fit snugly against the wall.

This new grommet consists of only two parts: an oil-resisting synthetic rubber disk, and a cadmium plated steel cup retainer for securely attaching grommet to wall. The packing member is an oil-resisting synthetic rubber block which affords many times the bearing surface characteristic of the old-fashioned grommet. The retainer cup has an opening large enough to slip over an assembled line or tube, including end fittings, eliminating dis-assembly of fittings during installation.

Multiple lines can be supported by a single Dura-Grom, individual openings being provided in the rubber disk for each line.

In addition to the fume- and water-tight features, Dura-Grom is said to save time on installation since complete tube assembly may be slipped through firewall and Dura-Grom retainer and permanently fastened at the ends. The split rubber disk is then easily installed by slipping it over the line, sliding the retainer into place and bolting it to the firewall, completing the installation.



Fume- and water-tight

CUSHIONED ABRASIVE

A light yet effective abrasive action is to be had through the use of an elastic-rubber compound impregnated with an abrasive, the rubber binding cushioning the abrasive to provide a smooth finish

on the work to which the material is applied. This cushioned abrasive, known as "Brightboy," removes light burrs and rough edges from die stampings, smoothes and finishes parts after surfacing or grinding, cleans and polishes edged tools, and so on. The elastic-bonded abrasive is available in tablet and stick form as well as in the form of wheels up to six inches in diameter, thus making the abrasive available for a wide range of operations.

EXTENSION BRUSH HANDLE

A paint brush or scraping tool may be secured by spring clips to the end of a new extension handle recently announced by Breinig Brothers, Incorporated, to

For hard-to-get-at places

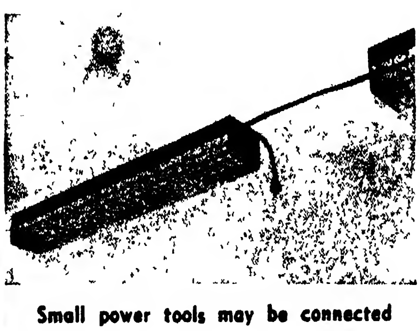
enable the operator to reach out-of-the-way places or high areas of walls or ceilings.

The angle which the short arm at the end of the extension handle assumes with relationship to the handle itself is controlled by the operator through a length of tape, and can be varied to suit the surface and position of the work.

DUPLEX LIGHT

A double-circuit mechanic's light with receptacles for plugging in small power tools and additional fixtures, being produced by the Lumidor Manufacturing Company, permits as many as four lights to be connected in line to a maximum of 60 feet from a single outlet, according to the manufacturer.

The "Mechanic's Light" was originally designed to illuminate the fuselage interiors of large aircraft during construction but the unit is being widely adapted to other industrial uses.



Small power tools may be connected

A 24-inch unit containing two 20-watt lamps and a 48-inch unit containing two 40-watt lamps are offered. Both units are available for either 50 or 60 cycle current. Brackets for hanging and a hinged wire lamp guard are standard equipment.

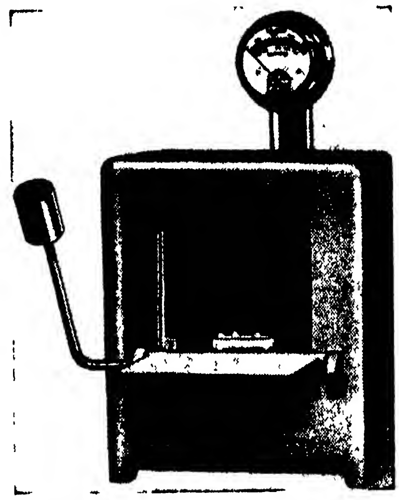
TANK AND PIPE LINING

Far down on the list of critical materials is a synthetic resin called Resoweld which is now available as a lining for tanks, pipes, fittings, pumps, and similar industrial equipment.

Designed to take the place of natural rubber linings where rubber cannot be used because of war requirements, Resoweld will resist alcohol, petroleum, gasoline, vegetable oils, and soaps, as well as nitric acid (with the exception of fuming nitric acid) and chromic acid. This new material is black in color and is thermoplastic, which indicates that practically the same application processes can be used as for natural rubber linings.

ELECTRIC FURNACE

Offering an economical, convenient, and rapid means of heat-treating small metal parts, as well as many laboratory advantages, a new electric furnace, shown in



Wide heat ranges are available

one of our illustrations, has inside dimensions of 3¼ inches in length and depth and four inches in width. Uses of the furnace include hardening or pre-heating, drawing and tempering, normalizing and annealing, enameling, and so on. In the laboratory the same unit may be used as an auxiliary furnace or to fill exacting requirements for testing or development work. Heat ranges up to 1500 degrees, Fahrenheit, may be obtained through rheostat adjustment, while provision is made for cutting out the series resistance and allowing rapid heating to maximum temperatures in a minimum of time.

PLASTIC SHEET

A laminated plastic sheet which has an opaque center and transparent faces has been developed for the manufacture of nameplates, tool checks, instrument dials,

and so on, to specifications. The opaque center carries printing or other marking, placed prior to the laminating operation, and the resulting sheet can be die cut, stamped, or drilled. The final permanent assembly measures .050 of an inch in thickness, is fire resistant, withstands a temperature to 200 degrees, Fahrenheit, and can be had in single or combination colors. Made by Plastic Fabricators, Inc., this sheet is available under the trade name of Durashield.

PART PRINTER

PRINTING of name, number, and so on, on shims, washers, name plates, and similar articles is speeded up by the foot-operated printing device illustrated herewith. At each pedal stroke the printing

Rubber, cork, plastic, felt, fiber, and other parts may be successfully printed on this machine

impression is made, while on the return stroke the printing dies or type are re-inked for the next impression. An adjustment is provided for locating various sizes of parts to be marked, these parts being placed in position when the foot pedal is up. The weight of this new Acromark printing machine is under 100 pounds, and it has been used succesfully to print on rubber, cork, plastic, cardboard, and similar pieces.

ALUMINIZED STEEL

BODY characteristics of mild steel with surface characteristics of aluminum are now provided in a new aluminum coated steel sheet. The material can be put through forming and drawing operations without peeling or flaking and is reported to be equivalent to solid aluminum sheet in corrosion resistance. Various thicknesses are available, a 16-gage sheet of the coated steel employing 5 percent as much aluminum as a solid aluminum sheet of the same thickness. The metal withstands temperatures up to 1000 degrees, Fahrenheit, without discoloration.

FLOOR PROTECTION

DESIGNED to protect walls, work benches, and similar surfaces from paint, oil, or grease spillage, Turco Duramask is painted over such surfaces and allowed to dry. This material is a thick, white liquid which is non-corrosive, non-flammable, yet is soluble in water. Thus, when paint or other materials are spilled on Duramask coated surfaces the accumulation can be readily washed off with water.

This paint-like material is applied thickly with a large brush, whereupon it sets within 30 minutes. When it is to be removed, together with accumulated surface spillage, it may be flushed off with a hose, mopped up, or removed with a floor squeegee.

SOLDERLESS TERMINALS

A SMALL wire terminal, which is rapidly applied to electrical conductors by means of specially designed pliers or by

One of the new solderless wire terminals, with and without insulating sleeve

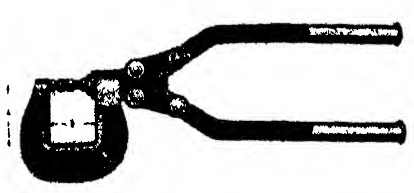
a pneumatic press, is applicable to various types of cables and wires ranging in size from Number 22 to Number 10. These lugs are available with various tongue shapes and dimensions, with or without an insulating sleeve upon which identification numbers can be marked, and with or without a sighthole for inspection of the connection

PLASTIC THICKNESS GAGE

THICKNESS feeler gage and shim stock of predetermined thickness is now available in a plastic material, the color of which identifies the thickness of the particular piece. The material is available in a range of 12 thicknesses from .001 to 030 of an inch and is known as Artus shim and feeler gage stock.

RIVET SQUEEZER

SUFFICIENT pressure to set up to 5/32 inch flat, round, or brazier-head aluminum rivets is obtained through the use of the Redi-Set hand tool shown in the accompanying illustration. The toggle handle



Plane of riveting center can be changed to exactly suit the rivets to be used

assembly is mounted so that it rotates at the head to permit accurate alignment over the rivet. Interchangeable dies are available for different sizes and shapes of rivets. The tool may be had with throat dimensions of 1¼ or 2½ inches and measures two inches between its faces.

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with the names of available books, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for. Books listed in these columns may be ordered from our Book Department.

THE MODEL PLANE ANNUAL 1943

By David C. Cooke and Jesse Davidson

Model plane construction and flying has led many a person directly into branches of commercial or military aviation. Hence the information presented here on model plane design and construction assumes particular significance at the moment. (224 pages, 7 by 10 inches, lavishly illustrated with photographs and drawings.)—$2.60 postpaid.—*A.P.P.*

INTRODUCTION TO NAVAL ARCHITECTURE

By John P. Comstock

Substantially the course in theoretical naval architecture given hull-drawing apprentices at Newport News Shipbuilding and Dry Dock Company by the author. Suitable for high-school graduates who have not had college mathematics, it explains fundamentals of naval architecture, how they are inter-related and progressively applied in ship designing. Not a substitute for standard references on this subject, but a study book and a guide to such publications. (209 pages, 5¾ by 9 inches, diagrams, tables, index.)—$4.10 postpaid.—*A.D.R., IV.*

FUNDAMENTALS OF MACHINES

By Charles E. Dull and Ira G. Newlin

Aimed at high school age pupils to serve as a pre-induction course, the text of this book will be found satisfactory as a simple but comprehensive reference source on the whole broad subject of basic machine principles. Supplementary material includes a glossary of terms, selected laboratory experiments, a mathematics refresher, a series of useful tables, and an index. (547 pages, 5½ by 8 inches, a large number of drawings and photographs.)—$2 10 postpaid.—*A.P.P.*

WINGED MARS. VOLUME I: THE GERMAN AIR WEAPON—1870-1914

By John R. Cuneo

In this book the author has done what the very latest authors on military aviation are doing—he has reviewed the growth of military aeronautics from the point of view of its use in strategy and tactics. But while Seversky, Ziff, Michie are attempting to define the functions and duties of the airplane of today, Volume I of Winged Mars studies the lessons of the past. It is most instructive, since this view is kept steadily to the front, to read of German military ballooning and of the beginning of anti-aircraft defense. In his chapter "Role of French Air Weapon" the author points out that the French did not have faith in aviation except for reconnaissance, and this lack of faith appears as one of the causes of the French disaster. While this book may not be of outstanding interest to the general public, it will be of very great interest to all those concerned with military or naval aviation, and from that point of view it will find its way into many technical and professional libraries, public and private. (338 pages, many drawings.)—$2.60 postpaid.—*A. K.*

THE AMAZING PETROLEUM INDUSTRY

By B. A. Kalichevsky

Most important raw material in the world, at the moment, petroleum is also the subject of innumerable industrial and military controversies. Here is good background material to serve in understanding the entire petroleum situation It highlights the history and present status of petroleum in non-technical language. (234 pages, 5½ by 8 inches, a few drawings.)—$2.35 postpaid.—*A.P.P.*

SERPENT OF THE SEAS

By Commander Harley F. Cope, U. S. N.

A submarine skipper and a line officer of the Navy, this author knows whereof he speaks when he outlines the world history of submersibles, their construction and motive power. He writes with equal facility on submarine attack, anti-submarine procedure, training of personnel, and the skilful and daring skippers of America's fleet of submersibles. (252 pages, 5½ by 8 inches, 17 illustrations, index.)—$2 60 postpaid.—*A D R, IV.*

THE FIRST CENTURY OF FLIGHT IN AMERICA

By Jeremiah Milbank, Jr.

Brought together for the first time in one volume, the widely scattered parts of this country's earliest aeronautical history will probably astound many readers. In 1784, a 13-year old boy was the first American ever to ascend in the air; nine years later came the first aerial voyage, with George Washington as a witness; balloon-reconnaissance played an

important role in certain Civil War engagements; 1878 brought a serious proposal to cross the Atlantic in 36 hours. Although claiming to be no more than an "introductory survey," this book opens up fascinating vistas of technological and social history by covering the period of American aeronautics from its beginning to the time when aviation had supplanted aerostation as the dominant concern of inventors and scientists. (248 pages, 5½ by 8½ inches, 40 illustrations.)—$2 85 postpaid.—*O.D.M.*

AUTOMOTIVE MECHANICS

By James V. Frost

DESIGNED for pre-service study, the text of this book has been made completely understandable to students. It covers motor vehicles from a description of the vehicles themselves through chassis, running gear, and body, to power unit, cooling system, and all the other intricate parts which must be familiar to the successful mechanic. Included are rules of the road, greasing charts and instructions, and a glossary of terms. (545 pages, 6 by 9 inches, over 350 illustrations.)—$2 60 postpaid—*A.P.P.*

JORDANOFF'S ILLUSTRATED AVIATION DICTIONARY

By Assen Jordanoff

THE book is really a dictionary of aviation terms and does not deviate from its fine purpose: the correct definition of aviation terms, suitably illustrated by simple, clear, and striking sketches. The selection of terms is excellent and includes almost all those aviation words likely to be needed by any except the best informed specialists. It covers such widely diversified fields as airplane strength; elementary aerodynamics; airships; propellers; rotating wing aircraft; instruments; and the like. A curious appendix exists in a glossary of aviation slanguage. (415 pages, 7½ by 10 inches, 2057 drawings.)—$3.60 postpaid.—*A. K.*

THE HOUSE OF GOODYEAR

By Hugh Allen

AN HISTORICAL survey of one company which has grown up with the rubber business, yet a survey which more than hits the high spots of the whole rubber industry. This is a particularly timely treatment of a vitally important and interesting subject. (417 pages, 6½ by 9½ inches.)—$2.10 postpaid.—*A.P.P.*

FUNDAMENTALS OF PERSPECTIVE

By Theodore DePostels, A.I.A.

A METHOD of showing the order, or sequence, in which lines of a perspective are drawn. Each line of a constructed perspective is numbered in the examples shown, and its direction is indicated by an arrow. To further clarify the examples, four colors are used to show what is given, what are the essential elements, what lines are needed for the construction of the perspective, and finally, the perspective

The Editors Recommend

Best Sellers in Science

PLASTICS — *By J. H. Dubois.* Meaty information on the whole general subject of plastics, presented in narrative form for easy reading. Tabulations of properties of plastics, plus basic design information, for laymen and technicians alike **$3.10**

EXPERIMENTAL ELECTRONICS — *By Ralph H. Muller, R. L. Garman, and M. E. Droz.* A solid book of eminently practical information on the characteristics and non communication applications of electron tubes. The text describes experiments and presents results For students, radio engineers, communications experts, and the serious general reader. **$4.75**

HOW TO READ ELECTRICAL BLUEPRINTS — *By Gilbert M. Heine and Carl H. Dunlap.* A chapter on how blueprints are made, plus nine other sections, each of which is devoted to a specialized part of the electrical field, from bell and signal wiring through motor control diagrams to power station blueprints **$3.10**

GET TOUGH! — *By Capt. W. E. Fairbairn.* How to win-in-hand-to-hand-fighting directions, by a man who really knows rough and tumble methods that are *not* "clean" fighting but *are* designed to win. **$1.10**

CHEMISTRY — *By Gerald Wendt, Ph.D.* Chemistry made easier by a presentation that is intermediate between popular works and classroom texts This book contains the main substance of a first year college chemistry course, giving the reader better than a sketchy background in this important science. **$2.35**

TECHNIQUE OF PLYWOOD — *By Charles B. Norris.* Technical information on all phases of ply wood manufacture and use, compiled for engineers, designers, and users of plywood Important to many phases of wartime housing and manufacturing problems. **$2.50**

FUNDAMENTALS OF RADIO — *By Jordan, Osterbrock, Pumphery, and Smeby.* With this one volume alone, and with some diligence of application, it is possible to obtain a thorough grounding in radio principles. In thoroughness of treatment, with due respect for the needs of the reader, this book is outstanding. **$5.10**

THE TRISECTION PROBLEM — *By Robert C. Yates.* Embodies mathematician's answer to would-be trisector. Gives chief dependable data on this never-ending dispute. Compact, crisp, concise **$1.10**

ELEMENTS OF ORDNANCE — A textbook prepared for cadets of the United States Military Academy. Covers manufacture, the chemistry of explosives, types of weapons, mathematics of ballistics, etc. **$6.60**

AIRCRAFT INSTRUMENTS — *By George Ellis Irvin.* All types of instruments for aircraft use described for students, pilots, inspectors. Fundamentals, instructions. **$5.10**

OUTLINES OF GEOLOGY — *By Longwell, Knopf, Flint, Schuchert, and Dunbar.* Complete, rounded coverage of earth science, both physical and historical. Explains all earth features and phenomena and includes mineralogy, glacial geology, and engineering geology. **$4.10**

MACHINERY'S HANDBOOK—*Eleventh Edition.* "Bible of the mechanical industry," enlarged to 1815 pages of latest standards, data, and information required daily in the shop and drafting room **$6.10**

PROCEDURES IN EXPERIMENTAL PHYSICS — *By John Strong, Ph.D.* A wealth of useful data of a practical kind for the constructor, experimenter, and skilled craftsman **$6.80**

STEEL SQUARE POCKET BOOK — *By Dwight L. Stoddard.* Practical methods of using the carpenter's steel square for layout work of all kinds. Time-tried methods used by two generations of carpenters and found both rapid and accurate **$1.00**

NORTON'S STAR ATLAS AND TELESCOPIC HANDBOOK — *By Norton and Inglis.* An old standby and most commonly used atlas for telescopes without setting circles 18 maps and 65 pages of compact notes and tables. **$5.00**

WORKING WITH THE MICROSCOPE — *By Julian D. Corrington.* For the serious beginner. Explicit, practical. **$3.60**

TOOL MAKING — *By C. B. Cole.* Instructions for making and using all kinds, from personal tools to arbor presses, lathes, planers, etc , in different metals **$3.60**

THE ELECTRON MICROSCOPE — *By Burton and Kohl.* A well written account of this newest tool of science, with all technicalities explained for complete understanding by average persons. **$3 95**

ENCYCLOPEDIA OF KNOTS AND FANCY ROPE WORK — *By Granmont and Hensel.* More knots are described in this remarkable book than in any book on seamanship ever published or dreamed of 3257 knots are illustrated in half-tone reproduction and are described in the text. **$5.10**

PLANT PROTECTION — *By E. A. Shurman.* All information necessary for those who would establish or belong to a plant protection group **$2.10**

A MARRIAGE MANUAL — *By Hannah M Stone, M.D., and Abraham Stone, M.D.* A practical guide to sex and marriage, covering fitness for marriage, mechanism of reproduction, prevention of conception, and similar vital subjects. Answers questions most often asked these authors by their consultants **$2.95**

PLASTICS, PROBLEMS AND PROCESSES — *By Mansperger and Pepper.* The whole story of plastics including a resume of manufacturing processes and a number of thorough going chapters devoted to plastic uses. **$3.10**

AUTOMATIC ARMS — *By Melvin M. Johnson and Charles T. Haven.* Comprehensively covers machine guns, machine rifles, sub-machine guns, pocket pistols, shotguns, sporting, military rifles in automatic classification. **$5.10**

BASIC FIELD MANUAL, INFANTRY DRILL REGULATIONS. Practical working manual for commissioned, non-commissioned officers **$.50**

HANDBOOK OF CHEMISTRY AND PHYSICS — A classic reference book recently revised and brought up-to-date to keep pace with recent research. Includes material on all branches of chemistry, physics, and allied sciences. Used in laboratories and by engineers throughout the country. Flexible binding, 2503 pages. **$4.10**

ATOMIC ARTILLERY — *By John Kellock Robertson.* Electrons, protons, positrons, photons, neutrons, and cosmic rays, all described for the layman in plain language Also transmutation of the elements and the manufacture of artificial radioactivity. **$2.35**

The above prices are postpaid in the United States. Add, on foreign orders, 25¢ for postage on each book, except as noted.

For Sale by: June, 1943

SCIENTIFIC AMERICAN, 24 West 40th Street, New York City

I enclose $ . . for which please forward at once the following books:

....

....

Name ....

Address ....

Write us for information on books on any subject. We can supply any book in print.

of the object itself. Use of colors, numbers, and arrows on the 20 loose sheets in the binder that comprise the publication eliminates much of the text formerly found in books on this subject. Contents include: Elementary; Ray Method; Net Method; Measuring Method; Definitions and Practice. (20 loose sheets, 8½ by 11 inches, in binder.)—$2.60 postpaid.—*A.D.R., IV.*

LEARNING TO NAVIGATE

By P. V. H. Weems and William O. Eberle

WHETHER totally inexperienced, or only partly familiar with the fundamentals of navigation, the reader of this book will find himself equipped with a foundation of the principles of navigation and the instruments used in that science. The text is designed to provide a practical handbook for navigation at sea or in the air. (135 pages, 6 by 9½ inches, 73 illustrations and four tabulations.)—$2 10 postpaid.—*A.P P.*

THE MAN WHO MADE NEWS

By Oliver Carlson

IN THESE days when news is at a premium, the life of James Gordon Bennett, Sr., who revolutionized journalism, makes good reading. Often designated the most widely hated and most generally read man of his day, this Scotch immigrant took the American daily press as dull, drab, and directed to a limited audience. He left it newsy, sensational, resting on support of the masses and the common people. Greeley, of the *Tribune;* Raymond, of the *Times;* Bryant, of the *Post;* Webb, of the *Courier & Enquirer* were contemporaries, and stout fellows in their own right. A thrilling saga of the Fourth Estate in Americana. (440 pages, 5¾ by 9 inches, index)—$3 60 postpaid.—*A.D R.*

ELECTRICITY

GROWING demands for a book on elementary electricity will be well supplied by the text of the present volume. It is aimed at the beginning level in defense training classes and covers all the important fundamentals of the subject. (194 pages, 6½ by 9½ inches, over 200 photographic and line illustrations)—$1.25 postpaid.—*A P.P.*

SKI TRACK ON THE BATTLEFIELD

By V. A. Firsoff, M.A.

POSSIBLY the first publication in English, on war-skiing, this book will intrigue both military and non-military readers with a first account of the ski-clad soldiers and their campaigns in Finland. Russia. Norway, the Alps, the Balkans, and the skill and daring of the snow armies. Developments in United States and Canadian armies are also enlightening, yet do not divulge military secrets. Technically sufficient for the professional soldier; sufficiently captivating for the average reader. (158 pages, 6 by 9 inches, 37 illustrations, index.) — $2.10 postpaid. — *A.D.R., IV.*

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

ASBESTOS FACTBOOK is a 16-page pamphlet which gives in compact form a wealth of information on asbestos. This includes the origin of asbestos, areas in which it is found, uses of asbestos and asbestos products, and typical analyses *Asbestos, 16th Floor, Inquirer Building, Philadelphia, Pennsylvania.—10 cents*

FLAKE SILICA-GRAPHITE PRIMER-PAINT is a four-page folder which gives condensed specifications on this type of surface coating for the protection of exposed metals and wood Flake silica-graphite is reported to be absolutely inert as a paint pigment and to be unaffected by heat, acids, and alkalies *Joseph Dixon Crucible Company, Jersey City, New Jersey.—Gratis.*

OUTLINE FOR POST-WAR PLANNING is an eight-page bulletin which presents certain basic elements that must be considered by any foresighted business man when planning an after-the-war selling program. *Tracy, Kent and Company, Inc., 515 Madison Avenue, New York, New York.—Gratis.*

HOT PROCESS WATER SOFTENERS is a 24-page pamphlet which describes the operation of lime and soda hot process water softeners, and the equipment with which this work is done in various industries. Outstanding features of the book are cross-sectional views of water treating plants and equipment. *Graver Tank and Manufacturing Company, Inc., 332 South Michigan Avenue, Chicago, Illinois.—Gratis.*

HOW TO LIGHT YOUR BLOW TORCH is a 22 by 34 inch wall chart which presents a cross section of a torch and a series of photographs which show precisely how to operate it. *Turner Brass Works, Sycamore, Illinois.—Gratis to training schools and war industries.*

AIR CONDITIONING is a 12-page article which deals briefly but concisely with many of the essential requirements for meeting war-time restrictions in heating and air conditioning design. Request Reference Section No. 9. *Industrial Press, 138 Lafayette Street, New York, New York.—25 cents.*

RADIO-FORMULA AND DATA BOOK is a 42-page pocket size pamphlet which presents a convenient collection of material for students and engineers in the field of radio and electronics. *Allied Radio Corporation, 833 West Jackson Boulevard, Chicago, Illinois.—10 cents.*

INTELLIGENT SELFISHNESS AND MANUFACTURING, by James F. Lincoln, is a 12-page dissertation on the whole question of incentive pay for employees and the advantages which accrue to the employer. Essentially the text is a record of the success of the incentive pay procedure as applied by one manufacturer. *The Lincoln Electric Company, Cleveland, Ohio.—Gratis.*

"THE INVISIBLE WORLD" AND OTHER STORIES is a 20-page booklet which presents a few of the adventures of nine scientists and engineers in the world of electricity. Many photographs and drawings illustrate the men's activities. Bulletin GES-2962 *Publicity Department, General Electric Company, Schenectady, New York.—Gratis.*

DOALL CONTOUR SAWS is a 250-page book with hard board covers which gives details on the development of contour sawing and filing machines, on tools of various types, on basic applications, and so on. Eighty percent of the text is given in picture form, with charts and diagrams presenting a complete grasp of the proper speeds and feeds to be used in the shaping of all basic materials *Doall Service Company, 1201 Thacker Street, Des Plaines, Illinois.—Gratis.*

KENNAMETAL TOOL MANUAL is a 48-page pocket size booklet which shows typical applications and uses of these industrial tools which are available in more than 30 standard styles and in four grades of hardness Information is also given on care and handling of these tools as well as on brazing and grinding. *McKenna Metals Company, 100 Lloyd Avenue, Latrobe, Pennsylvania.—Gratis.*

DRESINATE is an eight-page bulletin describing the properties of a rosin-base wetting agent for speeding up the action of alkaline metal cleaning compounds. Various industrial cleaning operations are expedited through its use. Request Bulletin PM-16. *Hercules Powder Company, Wilmington, Delaware.—Gratis.*

MICROMAX PNEUMATIC CONTROL is a 16-page catalog which describes and illustrates the use of this equipment for regulation of pH, conductivity, and other conditions in a wide variety of industrial processes. The control employs a system of balances which detects, while they are very small, any departures from the predetermined control point, and operates simultaneously, by means of air pressure, to correct them. Catalog N-OOB. *Leeds and Northrup Company, 4934 Stenton Avenue, Philadelphia, Pennsylvania.—Gratis.*

ALLOYS FOR UNCLE SAM is an eight-page description of three bronze alloys developed especially for the victory program, and a description of the specifications which they meet. Photomicrographs supplement the text. *Ampco Metal, Inc., 1745 South Thirty-Eighth Street, Milwaukee, Wisconsin.—Gratis.*

REFRIGERATION is a 48-page text book for home study, in which are presented the fundamentals of the refrigeration industry. The text describes various types of equipment as well as trouble diagnosis and service work. *Supreme Publications, 328 South Jefferson Street, Chicago, Illinois.—40 cents.*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

COLLIMATION is the accurate adjustment of the line of sight through a telescope after the optical elements and mounting are assembled. The number of letters received from telescope makers who indicate surprise that this should prove to be more of a job than they anticipated teaches us that it should have been stated without gloves in "Amateur Telsecope Making" that collimation generally is *not* easy, often is difficult, and usually accounts for hours of profanity and perspiration, and that this should be expected. You wrestle with the adjustments till you tremble, then lie awake after going to bed, trying to think out where you made your mistakes. You wrestle some more the next day, lose your fine disposition, appetite, about 20 pounds in weight, and eventually die of anorexia. But if you don't die, it's a wonderful feeling when you finally do get all the bugs out of the collimation job. So collimation is fine fun.

Collimating a Springfield telescope, with its extra reflection, is only a little harder than collimating a common telescope. We asked Russell Porter, who originated the Springfield, if this weren't true, and he replied that it's easier than falling off a log. From this, we sort of gather that there is a slight discrepancy somewhere. Was he pulling our leg?

Cyril G. Wates, 7718 Jasper Ave., Edmonton, Alta., Canada, has shown interest in collimating problems that wreck less agile intellects, and so we recently showed him a wail received from a Springfield mounting maker who was on the verge of death from collimitis. In return he showed us the reply he had thoughtfully sent to the sufferer. It was so lucid that we asked him to dish it up as an article. Here it is:

"I often find that it helps to visualize the problems involved in collimation if one thinks of the various optical axes as thin steel rods. If these 'rods' will turn freely in imaginary bearings rigidly attached to the mechanical parts of the telescope, collimation is bound to be perfect.

"In Figure 1, *D* represents the declination axis, and *a, b, c,* are cross-threads. I assume that the main mirror has been lined up with *a* and *b*. Now if the diagonal *P* is inserted and adjusted so that cross-wire *c* lines up with *a*, when viewed along the center of the declination axis, the telescope can be rotated on this axis without throwing the cross-hairs out of line, because all the parts involved are solidly connected together. However, the moment prism *H* is put into the path of the rays, another factor is involved, because *H* is *not* connected to the rest of the optical parts; it stands still while everything else turns around.

"Note that it does not make the slightest difference to the collimation whether the declination axis is at right angles to the tube or not, so long as the optical axis of the light cone coincides with the mechanical axis of the declination axis. It might be like Figure 2 without affecting the collimation adversely, since all the parts are united, and once having got the cone of rays truly centered in the declination axis, you may throw the rest of the parts, tube, mirror and diagonal, away, and forget them. This does not mean, of course, that the declination axis need not be at right angles; simply that its rectangularity has no bearing on the collimation

"Now, let's bring the prism *H* and eyepiece into the picture. These also are fastened together. Consider the point *Q* where the ray *cd* cuts the diagonal surface of the prism. If this point is exactly in the center of the declination axis, it makes no difference, as far as collimation is concerned, if the prism and eyepiece are all cockeyed.

"The whole thing simmers down to this: the ray *cd must* be lined up exactly in the center of the declination axis, and after that condition is secured, all adjustments can be made on the prism *H* and eyepiece without in any way affecting the collimation of the main tube.

"There is, however, a way in which the relationship between the declination axis and main tube affects the collimation. Picture the declination axis connected to the tube by a universal joint. Also picture the mechanical center of the declination axis as a thin rod protruding into the tube, and the optical axis of the tube as another thin rod. Obviously, these rods must intersect. Assume that they do intersect. Then the declination axis could be moved on its joint *longitudinally* without breaking the intersection (Figure 3). One rod slides along the other.

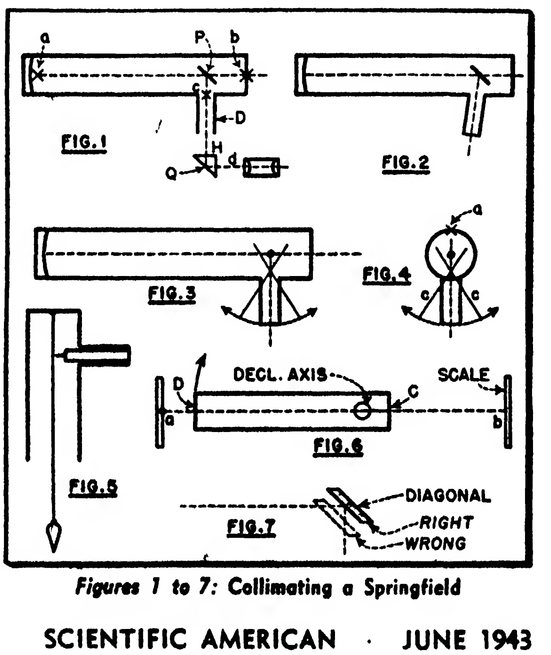
"If, however, the declination axis is moved *crosswise*, the intersection will break at once. (Figure 4). If the intersection is broken, it obviously will be impossible to reflect the central ray so that it follows the center of the declination axis, and I imagine that this is the commonest cause of trouble in collimating a Springfield. The remedy is to shim the tube in its cradle until the declination axis is square-on, but it is more difficult to design a method by which this squaring on may be accurately tested.

"One way would be by means of a wooden rod, turned in the lathe to fit snugly inside the declination axis and having a tiny pin in the center. This could be combined with a plumb-bob hanging axially in the tube (Figure 5). A simpler way is the old one of marking the point *a* (Figure 4) with great exactness, and sighting at it by means of cross-wires in the declination axis.

"Both these methods assume that the inside of the declination axis is concentric with the outside, which may not be the case; also they lack refinement. No pains should be spared to get this adjustment accurate, as everything else depends upon it. If it is not correct, one of two things will happen: either the central ray will be reflected *parallel* to, but not *coincident* with, the mechanical axis of the declination bearing, or the central ray will be cockeyed, like one of the lines *c c* (Figure 4). Either condition is clearly fatal to collimation.

"The best method is probably a modification of one described in 'A.T.M.' for lining up the declination axis, that is, by sighting at fixed posts and reversing the tube. Assuming that this already has been done, new sighting blocks are provided as near to the ends of the tube as will permit the head to be inserted at either end. The set-up is shown diagrammatically in Figure 6.

"In addition to the cross-wires, provide a disk of cardboard which can be attached to either end of the tube, with a 1/16" hole accurately punched to coincide with the intersection of the cross-wires. (I should make the disk first, and attach the cross-wires to intersect in the hole). Putting the disk at *C*, sight toward *a*, and put a dot on the block where the wires fall. Without moving the tube, put the disk at *D* and sight toward *b*, which



Figures 1 to 7: Collimating a Springfield

has a scale fastened to it. Note the reading on the scale.

"Without removing the disk, reverse the tube and line up the cross-wires on the dot, at *a*. Transfer the disk to the other end, and sight at the scale. If the reading is not the same as before, it is because the central line of the declination axis does not intersect the line joining the cross-wires (the axis of the tube). It must be made to do so by shimming under the saddle

"It may be found that, when reversing the tube, it will be impossible to line up the intersection of the cross-wires with the dot. It may fall above or below the dot. In such event, disregard the cross-wire which is at right angles to the declination axis, and merely make the wire that is parallel to the declination axis intersect the dot.

"The adjustment of the tube in the cradle to make both wires coincide with the dot involves shimming in both directions. The best way to accomplish this is a bit of a problem, which may be left to the ingenuity of the worker. Really, it is quite unnecessary to adjust longitudinally by shimming at the ends of the cradle (see Figure 2). All that is required is shims at one side or the other to 'roll' the tube in the cradle and bring its axis into coincidence with the axis of the declination bearing.

"These are the preliminary adjustments When these are complete, I should start collimating from both ends, and meet in the middle. Insert the main mirror and line up so that the optical axis coincides with the cross-wires. Insert *accurate* cross-wires at the inner end of the declination axis (*c*, Figure 1) A cap should be provided for the eyepiece adapter tube, with a small hole in the exact center Such a cap can easily be made of tin, and is a very useful gadget.

"Sighting through the cap, see whether the inner end of the declination axis, where the cross-wires are, lines up centrally on the face of the prism. If not, adjust the prism to make it so. I regard this adjustment as the least important of all, since a slight error here will not affect the collimation. It will simply cause a slight chromatic effect on bright images

"Now insert the diagonal in the main tube. Adjust this until the cross-wires at *a* (Figure 1) coincide with the cross-wires at *c*. It should now be possible to rotate the tube on the declination axis without separating *a* and *c*. If this is so, collimation is complete.

"Note, by the way, that the first adjustment of the diagonal should be to slide it longitudinally in the spider until the eclipse appears truly circular and centered in the declination axis, as viewed through the hole in the cap. Next, adjust by the push-pull screws until the cross-wires line up as nearly as possible. If this adjustment cannot be made exactly, it may be necessary to alter the first adjustment slightly. This is obvious when you consider that the face of the diagonal ***must*** coincide with the junction point of the two axes, as seen in Figure 7. Wherever I have spoken of the 'diagonal,' 'prism' may, of course, be substituted.

"Summarizing, the various steps are as follows:
1) Make cardboard disk and punch central hole.
2) Stretch cross-wires in main tube, centering by means of disk.
3) Square up declination axis by sighting blocks (Figure 6).
4) Insert and adjust main mirror.
5) Insert and adjust prism *H*.
6) Provide cross-wires in declination axis.
7) Insert diagonal (or prism) and adjust to make cross-wires coincide."

ROTOSCREEN: Before he joined the Army, William Waldeyer, of San Francisco, offered the following to other amateurs: "When an image of the Sun is thrown on cardboard (or any kind of screen, I suppose), the grain of the screen interferes with the sharpness of the image But if that screen is rotated or moved, the granulations or grains of the screen become invisible, while the image immediately becomes sharp and clear. The image, of course, is thrown on succeeding portions of the rotating screen, and the persistence of vision causes the image to clear up and become sharp. Sunspots, as well as the white flocculi of the Sun, become clearly visible on the screen. The idea seems so obvious that I don't doubt it's already in common usage—only I've never come across it"

Waldeyer made his rig from the motor-driven propeller shaft of a 15-cent toy electric boat.

TEST, never tried but offered for what it may prove to be worth, by J. R Haviland, author of the long treatise on

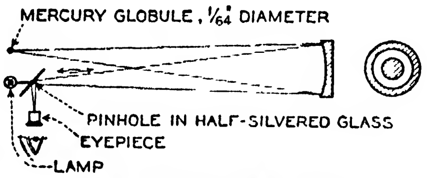


Figure 8. Haviland's proposal

the refracting telescope in "A.T.M.A.", is shown in Figure 8. Theory, says Haviland, suggests that it would be very accurate, but, he asks, will it work practically? He continues.

"Unless the center of the sphere of mercury, mounted on a micrometer screw, is placed accurately at the center of curvature, the image of the pinhole will not be sharp—a few thousandths of an inch of shift will blur it. Use a stop exposing one zone at a time, as sketched. However, as sketched, the returning focus falls concentric with the pinhole in the silver, and there would be difficulty in distinguishing which was which in the eyepiece. Perhaps it would prove necessary to use a pinhole in an opaque screen back of the glass.

"The accuracy would be better than one eighth of a wavelength at the peripheral zones For large mirrors this test would obviate the use of the customary flats."

IF YOUR local hardware dealer's truck, loaded with a shipment of Pyrex ovenware, should get into an accident and 200 pounds of Pyrex were broken, would you not, as a telescope maker, have the thought: "I could do things with that much Pyrex if only it were in the form of mirror disks"? Wilbur E. Gemmill, chemical engineer, 434 North Beaver St, York, Pa., ran true to amateur form when this happened in his community. He already owned equipment for melting down the fragments and he obeyed his TN instincts. It proved successful.

Into a graphite crucible he put 15 pounds of broken Pyrex and set this in his laboratory furnace. This he raised to 2500°, F., allowed the bubbles to rise through the viscous mass, poured the melt

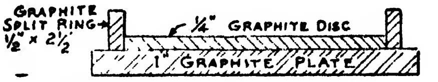


Figure 9: Gemmill's glass mold

into a mold (Figure 9) which had been pre-heated to 1500°, F., in a muffle. He left the poured glass in the muffle for 38 hours, during which the temperature was gradually allowed to fall by changing transformer taps. Next, it was left another 16 hours without heat, and removed at 110°, F.

"The disk made a fine mirror," he writes, "with no evidence of strains when tested with two Polaroids. It was ground, polished, and figured, and has been in use for over a year with beautiful results."

Did it pay? Of course not. Gas—electricity—time, a new Pyrex disk could be bought for less. Yet it did pay out—in fun "It was done," Gemmill says, "simply because of the intriguing nature of the problem."

"Subsequently," he adds, "I have melted down a local enthusiast's disk in which there was a crack caused by accidental dropping. The large chip thus outlined welded in and the cracks disappeared at about 2200°, F. I am also saving my broken laboratory ware to make two 10" disks to make flats.

"A local amateur made an 8" disk from scrap window glass. The pieces were washed with soap, rinsed, dried, fed, piece by piece, into an iron crucible, raised to 1800°, F., and held several hours for bubbles to rise. Poured into an asbestos-lined iron mold and covered with asbestos paper and iron, the glass was left to cool till no longer plastic It was then buried in about 15 pounds of house insulating material and allowed to anneal for 24 to 36 hours. It annealed quite well, as checked by two Polaroids, and seemed very uniform. The mirror took and held a good paraboloid."

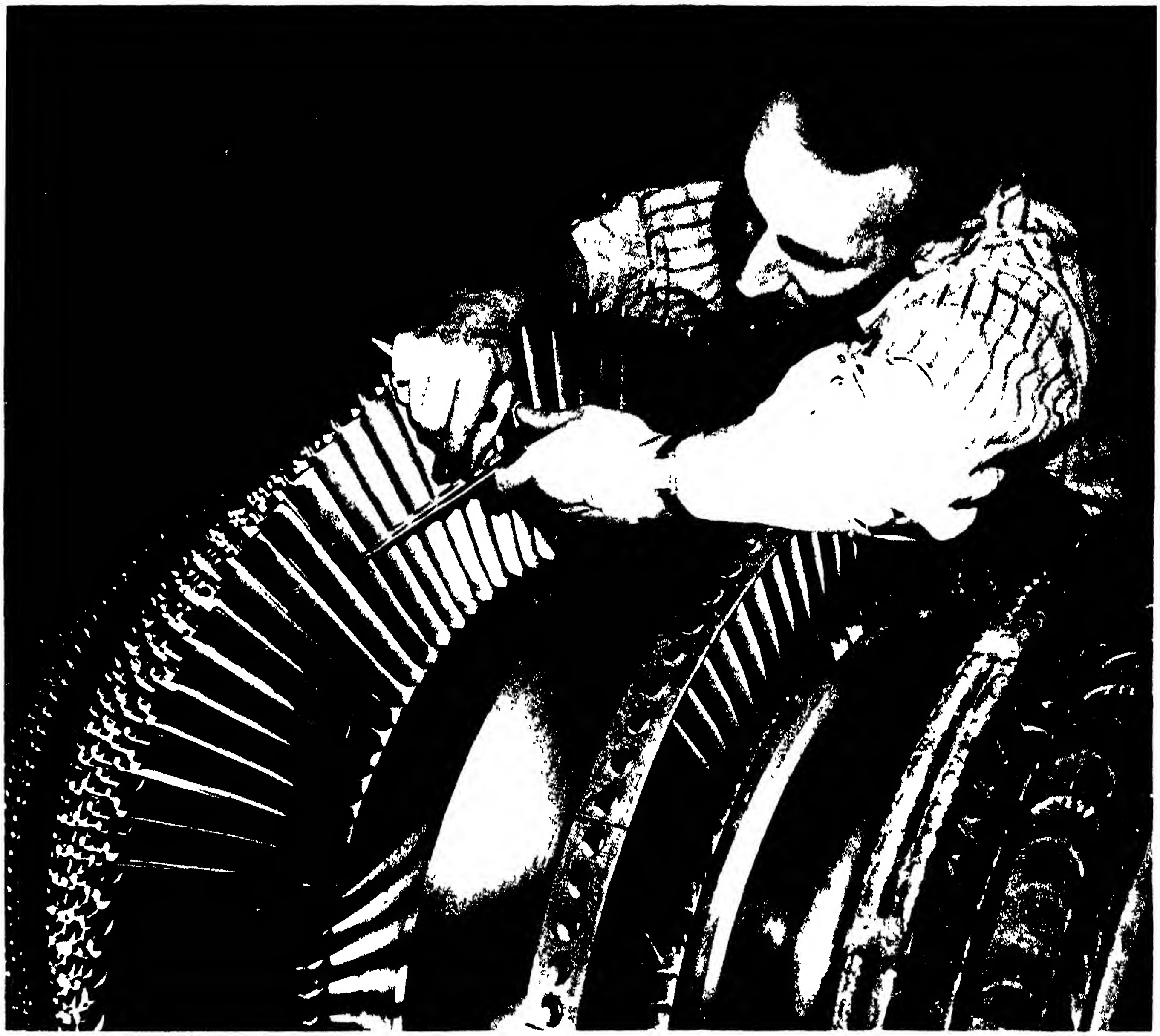
Again, all this is largely of general interest, alone, to the average amateur, because the necessary furnace is seldom available. Gemmill states that a home-made blower could be rigged up with an oil burner and some sort of retort. Again we have the intangible factor of fun pottering with gadgets, and when some too practical-minded critic comes along to remark, "Does it pay?" you say "No,"—and go on pottering, leaving him shaking his head. He will never understand the mainsprings of the experimental urge.

INDEX TO VOLUME 168, JANUARY—JUNE, 1943

Printed in the U. S. A. Press of the Wilson H. Lee Company, Orange, Connecticut.

CAN COLDS BE PREVENTED? Page 20

SCIENTIFIC AMERICAN



To Extract 2000 Horsepower from Steam . See page 1

Which comes first — Your second helping? or our second front?

YOU WANT TO SEE THIS WAR WON — and won quickly. You want to see it carried to the enemy with a vengeance. Okay—so do all of us. But just remember...

A second front takes food... food to feed our allies *in addition to* our own men.

Which do you want — more meat for you, or enough meat for them? An extra cup of coffee on your breakfast table, or a full tin cup of coffee for a fighting soldier?

Just remember that the meat you don't get — and the coffee and sugar that you don't get—are up at the front lines—fighting for you.

Would you have it otherwise?

Cheerfully co-operating with rationing is one way we can help to win this war. But there are scores of others. Many of them are described in a new free booklet called "You and the War," available from this magazine. Send for your copy today! Learn about the many opportunities for doing an important service to your country.

Read about the Citizens Defense Corps, organized as part of Local Defense Councils. Choose the job you're best at, and start doing it! You're needed—now!

Contributed by the Magazine Publishers of America

EVERY CIVILIAN A FIGHTER

CHECKING the spacing between the blades on a steam turbine spindle for a new war cargo ship is one of the exacting inspection operations in the production of these power plants For the first time in turbine history, such ship power plants — in this case developing 2000 horsepower per turbine — have been standardized and are being built on a quantity basis by the Westinghouse Electric and Manufacturing Company.

•

SCIENTIFIC AMERICAN

Owned and published by Munn & Company, Inc., Orson D. Munn, President; I. Sheldon Tilney, Vice-President; John P. Davis, Secretary-Treasurer; all at 24 West 40th Street, New York, N. Y.

NINETY-NINTH YEAR — **ORSON D. MUNN, Editor**

JULY • 1943

SCIENTIFIC AMERICAN, July, 1943. Vol 169, No. 1. Entered at the New York, New York, Post Office as second class matter June 28, 1879, under the act of March 3, 1879, additional entry at Orange, Connecticut Published monthly by Munn & Co., Inc., 24 West 40th Street, New York City.

Subscription rate $4.00 per year. Canada and foreign $5.00

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of July, 1893)

INVENTIVE CAMPAIGNS—"Thomas A. Edison, when he was congratulated upon his forty-sixth birthday, declared that he did not measure his life by years, but by achievements or by campaigns; and he then confessed that he had planned ahead many campaigns, and that he looks forward to no period of rest, believing that for him, at least, the happiest life is a life of work."

GREAT GUN—"Of all the foreign nations that are taking part in the World's Columbian Exposition at Chicago, Germany takes the lead, in extent, variety, cost and superiority in almost every characteristic. . . . The great Krupp gun . . . the heaviest piece of ordnance ever brought to an exhibition, is a 16.24 in. coast defense gun; the total length is 33.5 calibers, or 45 ft. 11 in.,

the length of bore being 41 ft. 8 in., the total weight is nearly 122 tons. This gun has fired sixteen rounds at the Krupp testing grounds at Meppen. During these trials the following results were obtained: The projectile weighed 2,200 lbs., and the charge was 902 lb. of brown prismatic powder; an initial velocity of 1,981 ft. per second was recorded, and the striking energy was 18,594 metric tons. We give a photographic view of the firing of this extraordinary weapon."

CYCLIST TROUBLE—"One evil traceable to bicycling is the confirmed stoop which has already declared itself in many wheelmen, a result so common in the less strongly built bicyclists of the Continent as to have found its way into classification as the 'kyphosis bicyclistarum.'"

CEMENT-IRON BRIDGE—"A new bridge was recently completed over the River Neutra, in Hungary, according to a system devised by Robert Wunsch, and consists of beton arches in which iron skeleton framework has been incorporated. The iron work comprises not simply single iron rods, but complete trusses made up of horizontal upper and parabolic lower chords. Cross girders and tie rods, however, have been entirely omitted and are supplanted by the beton. The wooden false work of the bridge was built to form a series of moulds, each mould constituting one complete bridge arch, and after the iron work had been put in place the beton was dumped in and thoroughly rammed. The work was divided up, so that the beton filling of each arch was completed in one day, and the false work was kept in place for an average of 37 days for each arch."

SUNLIGHT—"In the dark, and at moderate temperatures, the spores of anthrax retain their powers of infection for many months in any of the waters experimented with, fresh or sterilized. But in direct sunlight the spores undergo rapid destruction; and it has been definitely proved that this destruction is directly due to the light rays, especially at the blue end of the spectrum."

CLAMS—"A clam mine, full of live clams and of great breadth and depth, has been discovered at the mouth of the Delaware Bay, off the Flashing Creek shore."

MALARIA—"Dr. H. M. Clark has printed a memoir of his experience with malaria during a residence of nine years in India. How formidable a barrier to civilization malaria is may be inferred from the fact that to this disease alone is attributable not less than half the deaths throughout the world. . . . Only two races are proof against it, the Negroes of the grain coast of Western Africa and the Taurus of Northern India."

STEEL TIES—"The Mexican Railroad has now some 150 miles of track, including the Pachuca branch, laid with steel ties which weigh 124 pounds each, or 126 pounds with the two key bolts."

TELEGRAPH—"The United States minister at Peking, China, reports to the State Department that the Chinese telegraph system has been connected with the Russian system, so that messages may now be sent overland between any part of China, Russia, Europe, and by cable to Africa, North and South America, and Australia. The whole world is now wired and telegraphically connected."

TANK LINING—"A mixture of coal tar and California rock asphaltum has been successfully employed by Mr. R. C. Gemmell for lining a reservoir for the city water works of La Grande, Oregon. The reservoir is of oval shape, part in excavation in heavy clayey soil and part in embankment made from the excavated material, with inner slopes of three to one. . . . The lining consists of one layer of brick on edge, covered by three-eighths inch of the bitumen mixture"

SPEED GOVERNOR—"Perhaps the most severe test that a water wheel governor was ever subjected to is the case of a Pelton wheel running a set of circular saws at the mill of the Red Cross Lumber Company, in the northern part of California. The wheel is operated under a vertical pressure of 485 feet. The saws require to drive them through the log at full feed 125 H.P. They take about seven cuts per minute, thus varying from full load, namely, 125 H.P., to only what is required to drive the saws running free. During this operation the variation in speed is not perceptible."

TRANSATLANTIC—"The designer of the steamers Paris and New York, express . . . the belief that within ten years a vessel can 'leave New York at noon and arrive at Southhampton at noon on the fourth day out.' To do this . . . will require the enormous speed of thirty knots."

A LOT GOING ON IN THIS PICTURE— AND A LOT GOING ON IN INDUSTRY

It's big, dramatic. You can see it. But you can't see the idea that made it.

You can't photograph ideas. But they win wars. They make jobs. They make prosperity. They make well-being.

They used to come as a revelation once in a while, almost like a miracle to an individual. Now, there are teams that insure them.

Groups that keep ideas flowing. People who know how to dip into the wealth of nature for what they need.

They are scientists. They work together in laboratories.

They are working at the Bell Telephone Laboratories. Thousands of them. This is the biggest industrial laboratory in the world. Once its work was all telephone. To help your voice reach any one, anywhere. Easily, quickly, at low cost. Now it's war. Day and night. Seven days a week.

Our fighting men see the results of American research every day.

BELL TELEPHONE SYSTEM

Help the war by making only vital calls to war-busy centers. That's more and more essential every day.

OUR *Point* OF VIEW

HOW GREAT THE CHANGES?

THE enormous strides that have been made by science and technology during the past two years point irrevocably toward a bright new world when the clouds of war are dissipated and man can once more turn his hand to the pursuits of peace. Post-war planning is now upon us in full force. Out of such planning, coupled with the lessons learned in the laboratories and plants during the stupendous drive for war production, will come new developments that will stagger the average mind, that will make daily life far different in many respects than it has ever been in the past.

Such statements are irrefutable Readers of Scientific American have been following the reports—screened as they must be of necessity by the demands of wartime secrecy—of new developments in many fields. Foods, transportation, rubber, construction materials, textiles—the list could go on for many lines—all are being revolutionized by the results of the pressure under which science is now working and will continue to work until the last enemy of peace-loving nations has been subjugated. That the enlightened days to come will be better than any ever known in the past goes without saying

But will the world of tomorrow be so radically different from that of the past? True enough, there are indications that the "four freedoms" may eventually be guaranteed to every living person and that life in the future will be easier in many ways. The basic fundamental of all existence, however, is the person himself, stripped of the comforts and conveniences made possible by his environment. On this basis, then, will the new world be so far different from the old?

A look into the past may furnish an answer. These great United States were settled by farmers who were largely sufficient unto themselves. With their bare hands they carved a nation from the wilderness, fought for their ideals, laid the foundations for a great future built largely on courage, resourcefulness, and creative energy, salted liberally with a concern for the whole people rather than for the privileged few This democratic ideal worked Of course, it had its shortcomings, as will everything ever conceived by man. Yet, it worked It worked so well that the young nation flourished strong and mightily, gave birth to the industrial era that has made it outstanding among the countries of the world. Through all this the people as a whole remained unchanged in their devotion to first principles

Life speeded up Communications drew the far-flung parts of the nation closer together Transportation brought distant areas nearer, made interchange of goods and thoughts easier and more profitable to all Technology changed many pictures, giving radio, the automobile, better clothing, better foods, improved materials to the masses. Yet the ideal of democracy remained the unchanging factor in a changing world.

Will the future, then, from this standpoint, be so far removed from the past? We will fly to foreign lands in hours where the same trip formerly required days or weeks. We will have better homes, better automobiles, better communication systems. We will have plastics, synthetic rubbers, other products of the test-tube to make the way smoother or more convenient. We will be at peace with other nations in a world made more liveable by the products of science But in many respects it will still be the same old world, with ham and eggs for breakfast —*A P.P.*

ACCIDENTS?

IS IT derogatory to a scientific discoverer to say that his discovery arose from an accident? Is it little to his credit that, as is sometimes implied, he merely blunders on his great discovery?

In the midst of a most immediate war, British scientists have recently been discussing this question in their scientific journal *Nature*.

The consensus arrived at is that it is not derogatory to say that a scientist made his discovery by accident.

Perhaps in popular, story-book tradition a scientific genius proceeds to his triumphal discovery all according to an ordered plan. He knows in advance precisely what he seeks to discover and he proceeds on an undeviating line toward his goal. In actual fact, this has seldom happened in scientific research. The greater proportion of the big discoveries have been found along the road, generally off it and to one side of it, leading toward the discoveries the scientists originally set out to make—discoveries which, if they are then made at all, prove to be relatively less important than the ones that are made. Some examples:

Minkowski and von Mehring set out to discover the effect of the pancreas on digestion—a most worthy aim. They deprived a dog of its pancreas As a side observation of an apparently casual sort it was noticed that flies swarmed where the dog had urinated. They stopped to find out why. Sugar was found. Banting and Best were then able to go ahead and discover insulin for diabetics. Suppose, however, that one experimenter had said impatiently to the other, "That's off the main track. Come on and let's get going." We'd then have had a better understanding of the effect of the pancreas on digestion, but diabetics would not have insulin to keep them from dying.

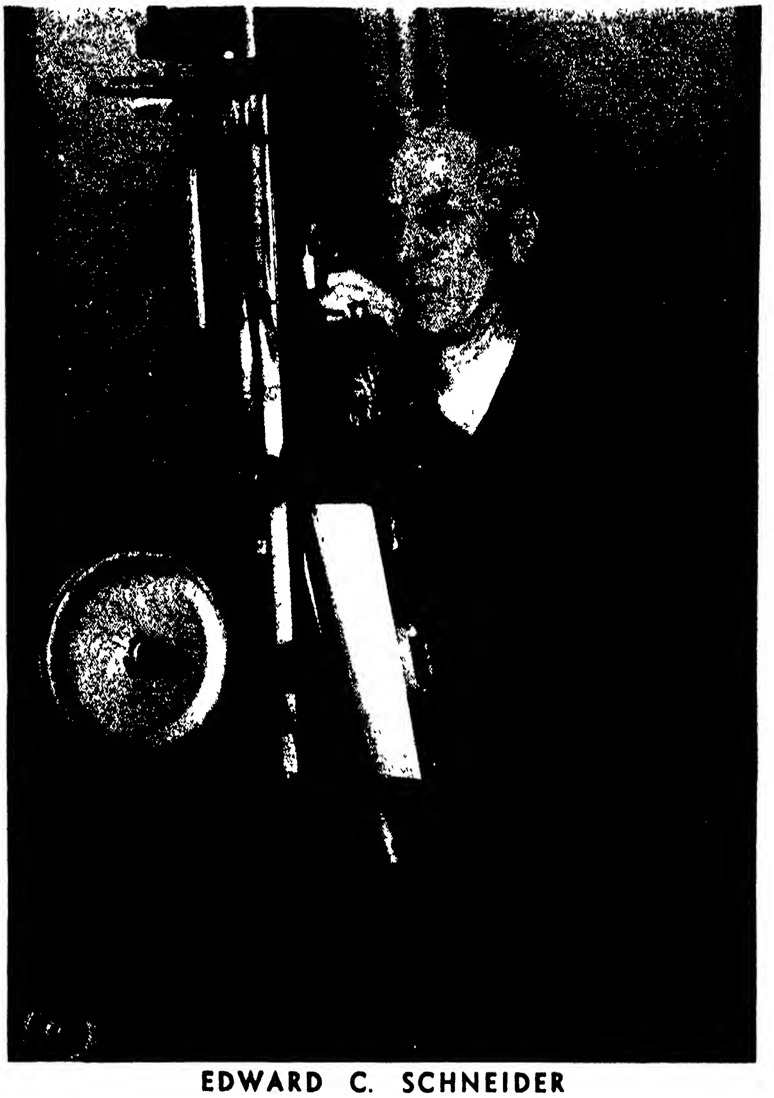
Another example: Roentgen discovered X-rays "by accident" Near a Crookes tube in a dark room was a platinum compound. When the tube was operated he noticed that this compound, which merely happened to be there among the physicist's typical table litter, gave off a dim light. Roentgen departed from the path to his intended goal to discover the X-ray. What the intended goal was is forgotten

Third example: Becquerel discovers radioactivity through a combination of plausible reasoning and accident. X-rays had been found to be caused apparently through fluorescence. Becquerel knew that some uranium compounds would fluoresce in sunlight, hence he planned to discover that X-rays could be produced by sunlight. He covered a photographic plate with black paper, sprinkled on this some uranium nitrate, and laid the whole in the sun. Result: The plate was blackened beneath the uranium. X-rays, therefore, were produced by sunlight. Being a good scientist he set out, however, to verify the demonstration by repetition. Unfortunately (or not) a stormy period intervened, so he kept the plate in a closet till the sun returned. Because of the interval he then thought perhaps a new plate should be used, but for some reason he *developed the one that had been lying in the dark.* The very same blackening! Gamma rays similar to X-rays had been emitted by the uranium all the time. He followed up the lead given by this "accident" (?) and suggested to Madame Curie the experiments that led to the discovery of radium

Were these accidents? Here is the nubbin of the matter. The word is a misnomer. In every case—and the history of science abounds with cases like them—the discovery was made through incidents, not accidents; incidents that were not of the scientists' intentional making. For it is no accident when the experimenter pauses to run up the side-alley and ascertain the meaning of the incident. Here is where the greatness lies—many of us (and many scientists themselves) pass straight over trifling incidents which may conceal riches. Among themselves, experimental scientists speak, in such cases, of following up a "hunch." But as "hunches" go, they are much more than the word usually connotes; they are not accidents, they are at worst unconscious cerebration, at best genius.

It, therefore, can be argued that discovery by "accident" represents a higher, not a lower, form than discovery by plotted design.—*A.G.I.*

Personalities in Science



EDWARD C. SCHNEIDER

WHEN a small group of pioneers in aviation medicine gathered in their shack in France some 25 years ago and heard a young, quiet-spoken member of their group expound his idea for a standard test to determine the fitness of aviators to fly, particularly at high altitudes, it is probable that few had any idea that they were approving a plan which would still be in use a quarter of a century later.

It is equally unlikely that any of the group realized that the plan would, some 25 years after, win the John Jeffries Award for 1942 given by the Institute of Aeronautical Sciences.

Edward C Schneider, Sc.D, professor of biology at Wesleyan University, was the young scientist who originated the Schneider Physical Fitness Index in that shack in France during World War I. A few weeks ago Dr. Schneider was the guest of honor at the Honors Night Dinner in New York of the Institute of Aeronautical Sciences and was recognized for his pioneering research in the field of aviation medicine.

Dr. Schneider displayed an interest in aviation medicine early in life and that interest has never waned After receiving his undergraduate training at Tabor College in Iowa (his native state), he received the degree of Ph.D. at Yale University and then joined the faculty of Tabor College and later Colorado College, where he taught biology, physiology, and chemistry.

During these years he was keenly interested in the studies of the physiological reactions of mankind to high altitudes at Colorado Springs and Pike's Peak and in 1911 was a member of the Anglo-American Pike's Peak Expedition studying mountain sickness and adaptation to high altitudes.

When the progress of World War I brought air warfare to the front, Dr. Schneider was a "natural" for the post of physiologist in charge of the Medical Research Laboratory set up in Washington by the Medical Research Board to investigate conditions which affect aircraft pilots and to provide tests and apparatus with which to counteract the ill effects of high altitude flying

The aeromedical laboratory was later moved to Hazelhurst Field on Long Island, then one of the larger pilot training centers, and a school for training flight surgeons was established, its first courses of study being arranged by Dr. Schneider. When a group of officers trained at the school were sent to France to establish a laboratory at Issoudun, Dr Schneider, then a Major, went along as a member of the Medical Research Board heading the group.

It was at this laboratory, about 150 miles from the battle front, that the Schneider Physical Fitness Index was developed and first put into use. It is a system of scoring men as to health and physical fitness by a simple standardized test of the heart and circulatory condition of the individual at rest and after a prescribed amount of activity. The test indicates, among other things, fatigue and general unfitness of the body before the condition becomes outwardly apparent. Thus the onset of "staleness" in a pilot who has not had adequate rest or recreation over a considerable period can be detected before his condition becomes serious and a possible nervous break occurs.

In addition to the research leading to this fitness test, Dr. Schneider has done a great amount of research on the effects of high altitude on the human organism, learning why some persons are able to withstand the ill effects of high altitude to a greater extent than can others. He has also devised apparatus for measurement of and protection against the effects of low oxygen intake. Experiments were made in high altitude airplane flights as well as in low pressure test chambers.

When the laboratory was reorganized as the Army School of Aviation Medicine, Dr. Schneider became physiologist and director of research as a Lieutenant Colonel. Until 1925 he divided his time between this and his post as Daniel Ayres Professor of Biology at Wesleyan.

Today, in his 69th year, Dr. Schneider is little changed from the days when he originated the "Schneider test." Aviation medicine is still his chief interest and his only regret is that he cannot play a more active part in the world conflict. He is, however, continuing his research in his quiet unassuming way and his findings may yet play an important part in aviation's part in winning the war.

SKY SENTRIES ON GUARD

Important U. S. Centers Are Protected by Barrage Balloons

R. G. PICINICH, JR.

HIGH OVERHEAD, the drone of many motors was heard as a squadron of Goering's Luftwaffe bombers appeared out of the East and headed across the English Channel. Spewed from captured French airdromes, the planes were on their way to carry another air blitz to London. It was a glorious moon-light night and visibility was perfect, except for occasional intervals when the full moon hid behind passing clouds.

A few minutes before ten o'clock, the first of the Nazi bomber fleet approached the British coast, flying in echelon. Soon the airplane spotters and fire watchers on the house-tops saw 24 Stukas silhouetted against the moon, no bigger than flies. In the distance could be heard the roar of many larger raiding craft. Crossing the coastline, each of the enemy planes dropped a single bomb at the shore installations far beneath them. This was more for psychological reasons than for destructive purposes. As the screaming projectiles fell, the gunners on the ground and house-tops sent up star shells, shining with magnesium brilliance, to high-light the ships of the attackers. Then, a green flare shot up just ahead of the first bomber and began to burn acidly in the sky. The glare lighted up the plane with a ghostly light and the sky behind was turned into a blue-black curtain Scores of white flares followed, dancing like gnats about the on-coming Stukas, and making each stand out in bold relief. As they flew inland, the bombers were pursued by a myriad of crisscrossing tracer shells and anti-aircraft fire.

The target tonight was the highly important Battersea power plant. The plant area was ringed about with barrage balloons. During the day, the balloons were lowered so that Nazi reconnaissance fliers could not see them. These hydrogen-inflated bags, with their intricate pattern of strong wire cables forming a formidable spider-like web, were directly in the path of the on-rushing bombers—on guard against their approaching dive attack. The sky sentries were placed at heights varying from 10,000 to 2,000 feet.

Concentrating on the target, the Stukas flew ahead swiftly and with deadly rhythm, the anti-aircraft fire forcing them to remain high in the air. As spotters and watchers continued to gaze aloft, the leader approached the objective and the dives started. The lead plane peeled off and plumeted down, at a speed of more than 400 miles an hour. It was quickly followed by the rest of the fleet, which dove like a wedge of destruction toward the power-generating buildings. A cloud had obscured the moon just as the plunge toward the earth began and nothing was visible to the pilots in the black-out below, particularly since they had just left the glare of the magnesium sky torches. Down, down, down, with the wind shrieking through the ailerons.

The bombardiers of the larger raiders dropped some of their eggs on the city as they sped overhead. The earth trembled to the blasts of the bombs spewed from the death-dealing aircraft Fires broke out in many different sections at once and a black pall of smoke hung above the roof-tops Columns of debris reared skyward, slowly mushroomed and fell back. A tremendous explosion resulted when several bombs landed in a concentrated area and went off simultaneously, ripping the curtain of smoke apart in a shower of sparks. From below, the 3-inch 50's barked—the 20mm's spat and sprayed

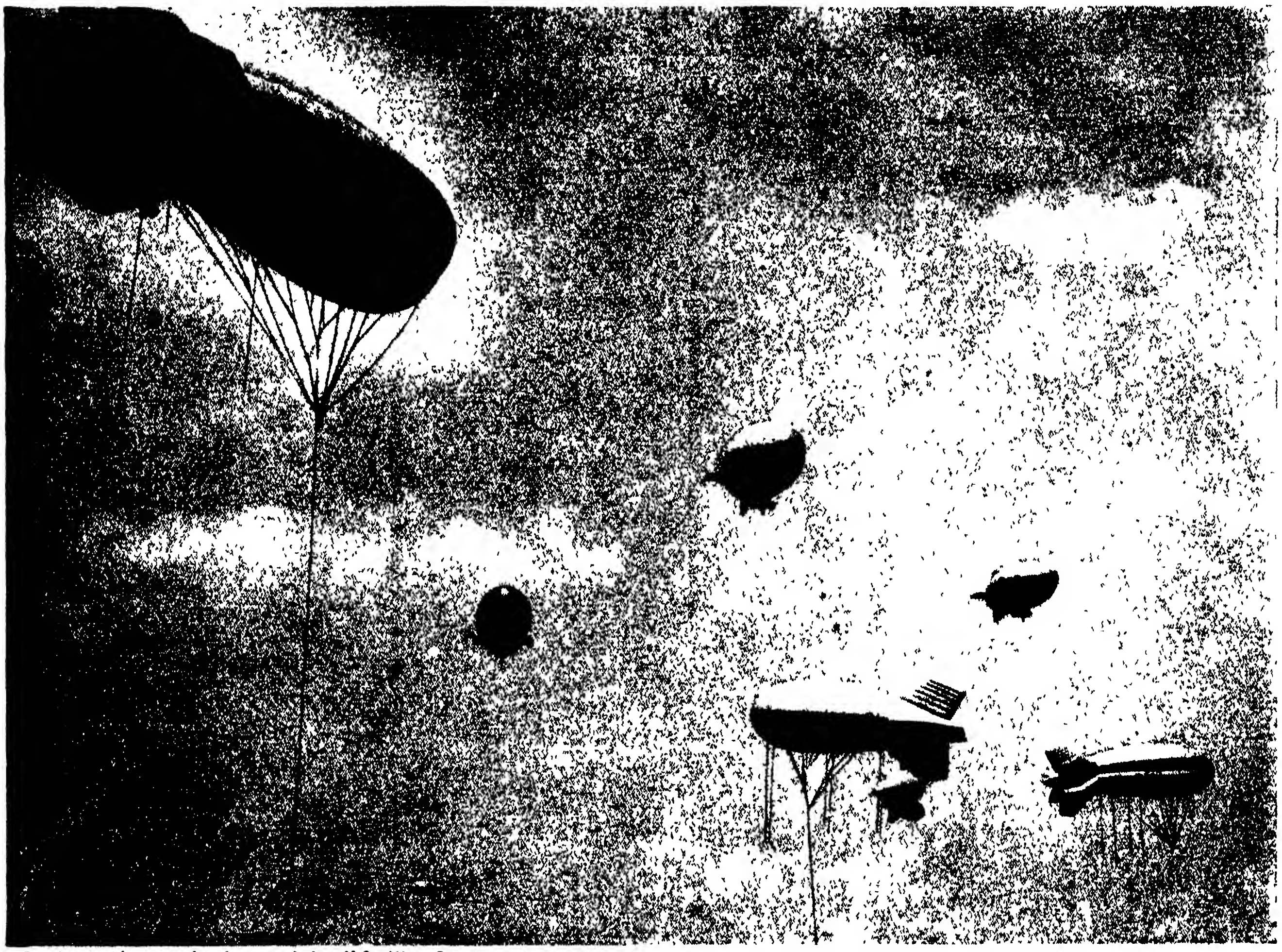
NOW THE Stuka squadron leader was on the target. His plane was coming down so fast that he never saw the barrage of balloons floating above. He crashed into the wire net, held aloft by the swaying bags, with such force that the rebound of the steel cables sent his Stuka hurtling back in the direction from which it had come. The ship, a mass of twisted metal, disintegrated in the air and went plummeting down to the inferno in the streets below.

At that moment the second bomber pilot saw the fatal predicament of his leader and, realizing the reason for the crash attempted to pull his ship out of its plunge so that he might rise above the obstruction. As he counted the seconds, the plane started up—slowly up, it seemed. As it gained altitude, the pilot suddenly saw a dark shadow above. It was sausage shaped and appeared to be of immense bulk as it loomed out of the dark. Too late! He could not clear it and plunged directly into the huge envelope. There was a rending, tearing sound as the plane went through the fabric, followed by a terriffic explosion as the hydrogen in the barrage balloon ignited. The airplane, ablaze, went spinning over and over toward the shambles below. The pilot could be seen by watchers, sitting in the cockpit, solid with flames, as he gave his life for his Fuehrer

THE SPIDER-LIKE strands of the steel net, which had been held up by the gas bag, came tumbling down—their weight rending, tearing and crushing anything and everything in their path. On its way down, the main cable, lashing about, struck a third one of the dive-bombers, when the machine was less than 2000 feet from the ground. The blow of the steel strand crashed through the gas tank and a flashing spark set the petrol afire. Blazing fiercely, and twisting over and over, the plane plunged downward when, suddenly, another speck appeared behind it. It was the pilot For a breathless moment his chute fouled the fuselage, then he broke clear In a matter of seconds the airplane struck.

The Luftwaffe pilots in the rear of the formation had witnessed the fate of their fellows and were making desperate attempts to either ride over or swerve aside from the barrage of balloons. Most of the bomber craft were able to do so, but one, brushing against one of the steel strands of the sky net, was blown to pieces in the air by the thousands of volts of static electricity with which the wires were charged As the plane exploded, its gasoline tanks burst into a mass of flames and spattered blazing fuel far and wide. The fuselage went into its last glide, losing altitude and streaming fire like a thrown torch

Another of the Stukas struck the main cable of one of the balloons. Although the bomber did not crash but managed to survive the impact, the steel strand which anchored the gas bag to the ground parted and away soared the sky sentry. With its cable lashing and slashing in deadly swings, the run-away craft was blown inland by an offshore breeze. Careening along on its rampaging flight, the balloon's trailing cable came in contact with a water tower atop a London



Goodyear Photograph, Approved by U.S. War Department

Barrage balloons, plus a new naval airship and two privately operated blimps

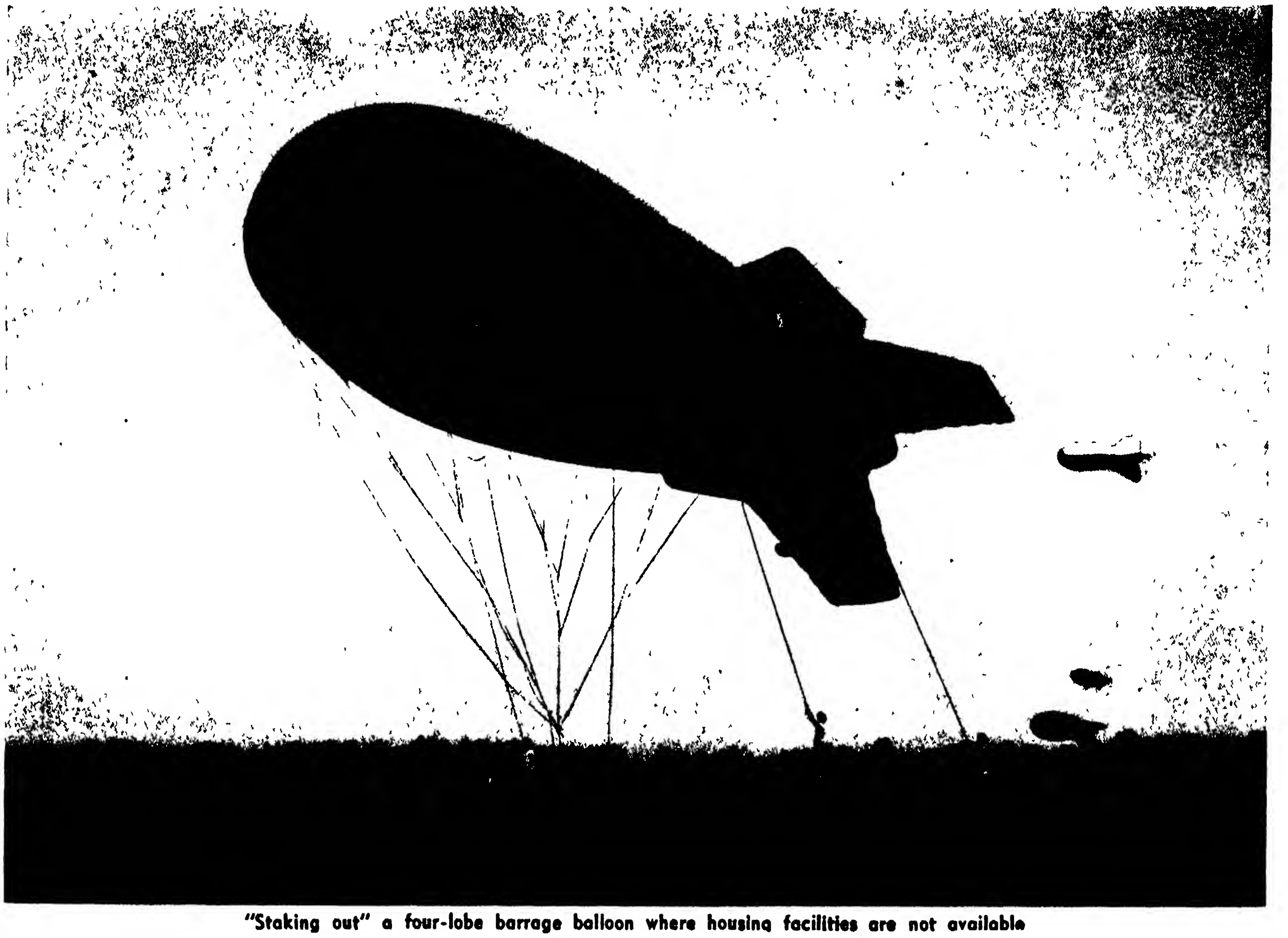
hostelry, coiled about it like the tentacle of an octopus, strained for a moment and then tore the tank loose, sending tons of water cascading down on the surprised blitz workers below who were expecting fire, bomb fragments, and mortar—but not a waterfall from the sky Free from this obstacle, the craft went sailing along again with the steel strand twisting and hissing snake-like as it swung through the night air. This time the cable wound itself about a church steeple and could not tear away. One of the Stukas, which had jettisoned its bombs and was winging toward the Channel, sprayed the bag in passing with incendiary bullets and the hydrogen-filled envelope exploded with a violence that sent the steeple crashing. The burning barrage craft fell on the church roof and soon that edifice was a mass of flames.

While incidents like the above have not as yet been experienced in the United States, we are prepared to meet enemy dive-bomber attacks, for we have built many hundreds of barrage balloons and are continuing to build them in ever-increasing numbers. Few persons have seen them and few probably will, unless or until an air attack is made on us. Battalions of trained personnel and the craft are housed in convenient places near vitally important targets—industrial and war plants, bridges, ship anchorages, overseas bases, sources of power supply, rail terminals, ammunition supply depots, and a hundred other critical points which we must defend at any cost.

Both British and American military experts are agreed that the barrage balloon is the best defense yet devised against the dive bomber. The sausage bags will be used in large numbers to defend important cities, such as the Nation's Capital; New York and Boston, on the East Coast; San Francisco and Seattle, on the West Coast, together with other installations vital to our war economy. To ring these about completely with anti-aircraft artillery would require a tremendous amount of costly equipment, but to cover certain areas with the less costly balloons and other sectors with anti-aircraft artillery will simplify the task and still provide a strong defense. Our army officials have been farsighted in this matter and are seeing to it that we shall be supplied with a sufficient number of barrage balloons for adequate protection in the event of an air invasion Most of the large rubber companies in the United States have been given contracts to produce the gas bags and are turning them out in quantity. The number of these balloons now available for the defense of our important cities and vital war installations is, of course, a military secret; enough, however, we are assured, have been produced to date to make our most highly vulnerable areas safe from Nazi and Jap dive bombers.

Aside from the uses already mentioned, the sky sentries are one of the best added defenses in the vital military zones of the Panama Canal, the Welland Canal, and the Sault Sainte Marie installations. To be assured of hits on these small targets, enemy pilots would find low flying or dive bombing necessary. By placing the bags, with their attendant deadly sky nets, in sufficient numbers about the areas, the enemy will be forced to fly at a height of more than a mile. The bomber's chances of registering a hit, at that altitude, even if he weathers the anti-aircraft gun fire, will be immeasurably less than it would be if he were free to approach close to the locks before releasing his bombs. The English have successfully protected Port Twefik, important Red Sea harbor through which much lend-lease material flows, at the southern end of the Suez Canal, with a screen of balloons. A recent and most effective innovation in the British Navy was to attach the gas bags to ships in convoy approaching home port, to protect the flotilla from enemy pilots who came out to attack. Since then, squadrons of Stukas have turned tail on seeing the balloon-protected ships.

When dive-bombers appear in the sky, speed in getting the bags into the air may spell the difference between the success or failure of a raid. No plane will willingly come near the dangling steel net held up by these sky sentries. The balloons are invaluable to anti-air-



"Staking out" a four-lobe barrage balloon where housing facilities are not available

craft gunners because they keep bombers high in the air, where the range of sound-detecting apparatus is truer. Failure to raise the usual barrage of balloons in one London area during a daylight vengeance raid, resulted in six Nazi raiders getting through the city's defenses. A school lost 48 killed, mostly children. Air Minister Sir Archibald Sinclair explained that the craft were down because of maintenance work being done on them. This would not happen in the United States for our men have been trained to use replacement bags in the event that any are temporarily out of service for repairs or routine inspections.

In today's global war, barrage balloons are the only lighter-than-air craft yet used by any of the belligerents—except for our effective use of the blimp for coastal patrol and convoy duty against the sub menace. Preliminary studies in the use of the balloons were made in this country by the Army Air Corps and this arm of the service is still charged with the development and procurement of equipment for the sausage bags. However, the craft are now in the charge of the Coast Artillery Corps, the only branch of our combat army that does not seek out the invader to attack him. Its purpose is to keep the invader away from places which he wants to attack. The first army barrage balloon school to be opened by the Coast Artillery was at Camp Davis, North Carolina, on July 28, 1941. Another training center is maintained at Camp Tyson, Tennessee, where there are facilities for the schooling of over 7000 men at one time.

Major General J. A. Green, Chief of the Coast Artillery, says, regarding the barrage balloon: "The number of airplanes brought down by these balloons is not to be regarded as a criterion of their value as a defensive weapon. In this respect they are in the same category as sea-coast artillery. If these coast batteries are so feared by the enemy as to prevent him from coming within range of their guns, they accomplish their purpose. It is just so with barrage balloons. The enemy, if he knows a barrage of the craft is in front of him, will avoid it every time. Since the gas bags can be anchored to trucks and readily moved about from place to place, they constitute a constant headache to the dive-bomber."

As to our being attacked from the air, Axis pilots have been kept so busy in the European, North African, and Pacific war theaters that they have not yet found themselves in a position to pay us any long-promised visits. The Fuehrer's intuition, particularly after the Russian debacle, should warn him that Nipponese boasts, made before the Jap withdrawal from Guadalcanal, will never materialize —just as the boasted taking of Stalingrad never came to fruition. It will be our diplomats who will direct the signing of the peace from Washington! Until then we will be prepared to protect not only the Capital but every other American city and critical installation from dive-minded enemy pilots—protect them with barrage balloons and with every other modern weapon and vehicle of offense and defense that is available.

• • •

WAR PRISONERS

Study and Teach Science Behind Barbed-Wire

Many outstanding scientists, as well as former teachers of scientific subjects in universities, colleges, and schools, are now in the war prison camps of the belligerent nations, according to Dr. Darius Davis of the War Prisoners Aid of the Y.M.C.A.

Such gifted prisoners help themselves and their fellows to endure the tedium of life behind barbed-wire by acting as teachers of scientific subjects in the educational programs for prisoners, stimulated and guided by the War Prisoners Aid of the "Y." Some of the prisoner-teachers have even written their own texts.

"Science holds an important place in the curriculum of this strange prisoner university, with branches in the war prison camps of almost all of the belligerents," says Dr. Davis. "British prisoners in Germany alone have requested more than 420 university courses! The aim of the program is not only to prevent despair and deterioration in men penned-up and idle, but also to preserve for the post-war world the wealth of scientific attainment in today's prison camps."

Sugar, A 'Chemically-Pure' Food

Highly Technical Industrial Processes, Plus Efficient Operation of Plants, Produce Beet Sugar at Low Cost

ROY H. COTTRELL
Vice President and General Superintendent, Amalgamated Sugar Company

SUGAR has always been a low-price food, and is even today. Yet sugar, whether derived from cane or beets, requires high skills and relatively large investment on the farm, as well as heavy investment in processing plants and highly technical processing. The laboratory alone in a sugar factory requires greater investment than the total plant required to clean navy beans on a large scale, for example, although the price of dried navy beans at any corner grocery is about 50 percent higher per pound than the price of refined sugar. Yet beans constitute a crop easily raised in a short season with minimum agricultural hazard, require almost no processing, are non-perishable, and need no special handling. As a matter of fact, no other food product, which requires a raw material subject to agricultural hazards as well as highly technical processing and high standards of purity, is generally sold to the public at such a low price as sugar.

This is only one of the aspects of sugar that give it new perspectives against the background of war. Long an essential part of the diet, sugar has now become more than ever important in the conservation of other foods by canning, and one of its by-products—molasses—is a raw material for ethyl alcohol, which has a wide variety of essential war uses.

The outbreak of the war changed almost overnight the conditions within the sugar industry. With the loss of the Philippines, the United States was cut off from nearly a million tons of sugar which is normally received from that source. Submarine warfare in the Caribbean made shipment from Cuba and Puerto Rico hazardous and uncertain. To some extent the usual commerce in sugar between Hawaii and the mainland was interrupted. The combination of these circumstances made the United States more than ever dependent on internal production of sugar.

The backlog of beet sugar at the beginning of the war may, in large measure, be considered a reflection of advances which have been made within the industry since World War I. Not only has average production doubled within that period, but significant improvements have been made in the agricultural and industrial techniques.

Eighty-five beet sugar factories are scattered from Ohio to California, but in a true sense they do not manufacture sugar. Sugar is "manufactured" in plants alone, by the process of photosynthesis. Man contributes to sugar production only to the extent that he devises ever more efficient methods of extracting sugar from the cells of plants. The sugar of commerce is sucrose, a chemical compound having the formula $C_{12}H_{22}O_{11}$. Sugar cane and sugar beets store sucrose in relatively larger quantities than other plants, and for that reason they have become the most important sources of commercial sugar production. The completely refined product from these two sources is identical in all respects and may be used interchangeably for all purposes.

"Worm's eye" view of sugar beets ready for harvesting

Although there are minor variations in the details in the processes of extracting sugar from beets, in general they consist of five major steps: Extraction of sugar from the plant tissues in the form of dilute juice; purification of the extracted juice; concentration of the sugar syrups; crystallization; and recovery of the crystals in final commercial form.

After the beet roots have been washed to remove soil and other foreign matter, they are sliced into short, thin strips resembling shoe-string potatoes and called "cossettes." These cossettes are introduced into a diffusion battery, which consists of 14 vertical, cylindrical tanks which will hold several tons each. A fairly concentrated solution of sugar in the form of beet juice is passed through the fresh cossettes, and by a combined action of diffusion and osmosis a part of the sugar in the cossettes is recovered in the juice. The juice is drawn off for further treatment, and the cossettes are treated again with a juice of somewhat lower concentration. Again the juice takes up a part of the sugar in the sliced beets, and the juice so obtained is used to treat fresh cossettes. In this manner the sliced beets are treated with juices of progressively lower sugar concentration, and in each step the juice gains sugar and the slices lose it. In the last of 11 such treatments, water is passed through the slices.

When the cossettes have been fully subjected to the extraction processes, they are pumped to silos or to drying plants, and eventually are used as stock feed. They contain about 0.2 percent of sugar, the recovery of which would entail a cost in excess of the value of the sugar recovered.

The "raw juice" drawn off from the diffusion battery, containing approximately 13 percent of sugar, is next treated to remove the maximum amount of non-sugars before crystallization. The method universally employed consists in rendering the non-sugars insoluble by heat and chemical reagents, and in removing the resulting precipitate by filtration. The extent to which the non-sugars are eliminated determines the amount of sugar which can be recovered by crystallization.

The temperature of the raw juice is first raised to 85 degrees, Centigrade, and is then pumped to the "first carbonation station." Here milk of lime is added to the juice, the mixture is agitated, and carbon dioxide bubbled through it. As CaO and CO_2 react to form $CaCO_3$, a floc is formed which occludes suspended solids. The addition of carbon dioxide is continued until a definite floc appears, or until a predetermined level of alkalinity is reached. The juice is then passed through heaters and subsequently filtered.

The resulting juice is amber-colored and sparkling clear, having lost more than a third of its organic non-sugars during filtration. The organic non-sugars thus removed form a part of the filter cake which is washed with hot water to free it of juice and discarded as waste. The wash-water, known as "sweet water," is

used in the preparation of milk of lime and the sugar it contains is ultimately recovered.

After a second carbonation and filtration, the juice is pumped through a heater to the top of a tower in which it trickles down over baffles. Sulfur dioxide gas is introduced at the bottom of the tower and spent gases are drawn off at the top Sulfur dioxide serves to lower the alkalinity, reduce the viscosity, partially bleach the juice, and kill bacteria

The juice is then filtered once more It is now a light, straw-colored liquid of about 12.0 percent concentration of sugar, and about 13 5 percent total solids, including sugar.

CONCENTRATION is accomplished in two operations. A preliminary concentration takes place in multiple-effect evaporators, followed by further concentration in the vacuum pan. Operation of the evaporators is entirely a mechanical process and will be discussed in connection with a description of fuel economy methods later in this article.

After leaving the evaporators the syrup, now having a concentration of about 65 percent sugar, is heated, blended with melted low-grade sugars and syrups from subsequent processes, and filtered. It is then drawn into the vacuum pan and boiled until supersaturation occurs and seed crystals appear. Samples are drawn from the pan frequently and examined by the operator to determine concentration and the number and size of crystals.

When a sufficient number of these seed crystals has appeared the operator reduces the degree of supersaturation by raising the temperature and by the addition of unsaturated syrup From that point forward, the operator adds syrup at a rate which will maintain the appropriate degree of supersaturation Seed crystals previously formed grow under these conditions, but no new crystals are formed. The operator must be able to judge the point at which no more seed crystals will be formed in order that the crystals will be of a desired size when the pan is full. The process of "boiling" requires the highest skill of any operation in the factory.

Once the vacuum pan is filled and the sugar crystals have reached the proper size, the contents are dropped into a jacketed, heated mixer located directly above centrifugals. The mixture of crystals and syrup is called "massecuite" or "filmass"—terms borrowed from the French and German.

The massecuite is next introduced into a centrifugal The basket of the centrifugal is perforated, and lined with a brass screen having perforations so small that sugar crystals cannot pass through them.

When sugar beets enter a factory, they are first thoroughly washed, after which they are lifted by revolving paddles to a "roller picking table," shown above, where jets of water remove any remaining foreign matter

A typical sulfur station in a sugar-beet factory, where the extracted juice is treated with sulfur dioxide

With the centrifugal in motion, syrup is forced through the screen and basket walls and escapes into storage tanks. Sugar crystals are retained around the basket lining. There, while the machine is in full speed, the sugar is washed with hot, distilled water to remove adhering syrup. On further spinning the sugar is dried to about 1 0 percent moisture content. From the centrifugal the sugar is passed through a drier, in which the moisture content is reduced to 0 025 percent, and the sugar is ready for packaging and delivery to market

SUGAR for household use must meet rather simple, easily attained standards of purity, sanitation, size of crystal, and packaging On the other hand, certain industries such as baking, confectioneries, preserving, canning, and soft drink manufacturing, have developed such highly technical procedures that the sugar used must meet exacting specifications Since a beet sugar processor operates for a relatively short season of the year, he cannot anticipate his sales with an accuracy that will permit him to set aside particular lots of sugar for particular buyers. He must, therefore, maintain high technical standards for his total production.

Except for highly specialized use. the following specifications are typical of refined sugars offered in the general market.

Moisture	0 025 percent
Mineral Ash	0.009 "
Sulphates	Less than 5 parts per million
Organic non-sugars	Trace

In addition, a syrup formed when sugar is dissolved in distilled water in 50 percent solution must be water-white and free of turbidity. It must not show appreciable turbidity upon addition of ethyl alcohol.

It will be evident to the chemist that commercial refined sugar is more highly refined than many laboratory reagents

Vacuum pans for concentration of beet-sugar juice

graded "chemically pure," and in addition it must meet the biological standards of a pure food.

How is it that a "chemically pure" product can be placed on the market at the current prices for sugar? The answer lies in part in the technical efficiencies and economies practiced in sugar manufacture, among which the control of fuel may be cited as an illustration.

In a typical factory, pulverized coal of about 12,300 BTU is burned in two boilers. At maximum load each boiler generates 100,000 pounds of steam an hour at 200 pounds pressure. Efficient generation of steam requires this pressure, but since the pressure is too high for safe use in the manufacturing process, it is put through turbogenerators, and the exhaust at 22 pounds is used in the process. As a result, sufficient power to operate the 300 motors in the plant is obtained as a by-product of the pressure reduction. In fact, an excess of power could be generated since some live steam is added to the exhaust to furnish sufficient process steam.

The exhaust goes directly to the first effect of a quintuple-effect evaporator system. Vapor removed in the first effect is used as steam in the steam-chest of the second, vapor from the second is used in the steam-chest of the third; and so on until the vapor from the last effect is passed to the condenser. All non-condensible gases are removed from the condenser by a vacuum pump. The temperature difference between the exhaust steam in the first effect and the boiling temperature of the juice in the last effect may approximate 70 degrees, Centigrade. Divided between the five effects it is sufficient to insure a r[illegible] rate of heat transfer through the wa[illegible] of the tubes.

As a result of this system the live steam first furnishes power, then it is used five times over in evaporation. But this is not all. Vapor from the first three effects is also used for the juice heaters and vacuum pans. The heat remaining in the condensate from all effects and the pans is partially recovered by using the water for boiler feed water, for washing press cake, and for other process purposes. It is pure, distilled water. The evaporators in a medium-size plant remove in excess of 100 tons of water every hour for 24 hours a day. Efficient combustion of coal in the boiler furnaces, a high boiler efficiency, and economic use of the steam generated, result in major fuel economies. Where formerly it required as high as 160 pounds of coal to produce a pound of refined sugar only 60 or less are now required. Since a plant of this size produces 360 tons of refined sugar per day, the saving in coal is a substantial amount.

In recent years similar although less spectacular savings have been made in the use of other operating supplies, all leading to the low sale price of sugar to the consumer.

• • •

DIE PRODUCTION

By New Method Reduces Time and Labor Requirements

LARGE-SCALE manufacture of "template dies" for the aircraft and similar industries, as well as fixtures, will, by new production methods, save 3/4 of the time required to produce the dies while reducing die cost 65 percent. Hundreds of individual dies have already been produced by Algoma Products for the aircraft industry as a result of a preliminary announcement of this new development to a few aircraft manufacturers.

In view of the fact that it is necessary for the aircraft industry to continuously modify designs of aircraft as battle experience is gained, it has become particularly vital that such changes shall be effected in the minimum of time. In the past, it has taken a long time to prepare die designs and produce the new dies required before a change can be put into effect. It is claimed that with Algoma template dies and the production process which has been evolved, it appears possible to do in a few hours what normally requires weeks, even months. The new dies eliminate entirely the necessity for separate die design and do not require highly specialized production equipment. Moreover, the process has been laid out in such a manner that large numbers of die makers are not required. Much of the production can be handled by mechanics with only normal skill in the operation of specific types of conventional machine tools.

ODOR PROBLEMS

Present a Challenge to Industrial Chemists

THE IDEA of a universal deodorant which would, by physical or chemical action upon any odorous substance, completely destroy it and thus do away with its odor, without introducing any odor of its own, has been proposed from time to time by ambitious inventors, but so far it is still just an idea.

When all of the usual approaches to a deodorizing problem fail—and they do frequently—the art of "odor neutralization," which is a branch of perfumery, may help. While by no means universally applicable, this method utilizes the offending odor as a constituent of a "bouquet"—as it were—of various aromatic substances, so that the offending odor is transformed to a pleasant or even a neutral one without any need of "covering it up" by sheer brute force of an overwhelming stronger odor.

The "odor neutralization" method has been very successfully applied in a large number of industrial instances, such as the rubber, textile, glue, and paint industries, to mention a few. The selection of the correct deodorizer or "reodorizer" is a highly specialized job—there is no such thing as a universal deodorant in this line, either. The laboratories of Givaudan have solved a number of such problems which are today making many articles of commerce more acceptable to the public. Usually the "deodorized" articles are rendered almost neutral, thus causing little comment among the public. But the initiated know and appreciate the value of these deodorants since they have seen their sales go up after they were used. The problem of neutralization or reodorization is a particularly acute one today for the synthetic rubber industry.

MICA REPLACEMENT

New Synthetic Has Great Possibilities in Electronics

A SERIOUS shortage of our strategic mica reserve, now largely imported from India by cargo planes, has opened enormous possibilities for the use of a new synthetic in electrical condenser-development work for electronic apparatus having Army and Navy applications.

The new synthetic plastic, "Polectron,"

achieves importance in two ways—first, as a primary substance materially reducing the drain on our domestic and imported strategic mica stock pile; second, as a dielectric material possessing controlled properties having wider applications than mica.

The composition and production of "Polectron" synthetic must remain a military secret until after the war. It will be made available to the electronic industry, thus releasing mica to other uses for which no substitute has yet been found.

As a part of its expanded research and development program, General Aniline and Film Corporation developed Polectron synthetic in a remarkably short period of time This required by-passing intermediate steps normally taken in peace times between laboratory and plant production Omission of these steps may bring unforeseen problems and even delay in plant operation. However, priorities were granted for the immediate production of Polectron synthetic based upon the following considerations It will save strategic mica and thus reduce the present drain on the imported stock pile The continued availability of sufficient block mica, transported to the United States by cargo plane, is uncertain. It is estimated that one ton of "Polectron" fabricated into mica replacement material will replace from 10 to 15 tons of imported block mica, according to its use. "Polectron" can be used in the production of electronic apparatus without material changes in equipment or methods of manufacture.

Polectron synthetic is now undergoing further experimentation, pointing toward the solution of major electronic problems important to the war effort.

WAR ON ACCIDENTS

Turns Attention to Industrial Safety Shields

AMERICAN workers are becoming more and more safety conscious That's not new news, but it's good news for the production front More than 42,000 war workers lost their lives the year after Pearl Harbor because workers chose to risk a particle in the eye rather than wear safety goggles, or preferred to take a chance on burns and broken fingers rather than bother with protective "gadgets" The score that year must have pleased certain gentlemen in Europe and Japan, but it was a mighty sore point over here To pull the accident rate out of this rut, the National Safety Council early in the war launched an all-out drive to make workers more aware of the importance of being earnest about safety devices. Results have been good. In one plant, eye-injuries—which formerly accounted for 32 percent of medical treatment cases — dropped to half in five months. In all plants workers have become so safety conscious they not only willingly co-operate in the use of devices available, but also spend time dreaming up some of their own.

One of the favorite materials from which workers now cook up safety devices is a transparent plastic, scraps of which are often left over from the Plexiglas bomber "noses," gun "blisters," and other enclosures made in aviation plants. This material has virtually perfect transparency and high impact strength, but equally important is the fact that shields are made simply by heating Plexiglas sheets a little hotter than boiling water, cooling over a form, and trimming to size with ordinary saws.

Beech Aircraft workers, to protect themselves from flying tacks in making

Safety shield prevents accidents

fuselages, have adopted Plexiglas face shields; Consolidated has worked up transparent Plexiglas skirts for drill presses; Bell Aircraft's electrical department places transparent Plexiglas shields over soldering pots to prevent spattering of molten metal; at Republic, tough, transparent saw-shields protect workers from metallic particles; at McClellan Field, Plexiglas workers have devised safety gadgets ranging from Plexiglas ear plugs to machine shields

LACTIC ACID

Makes Sour Milk Sour, Has Many New Industrial Uses

LACTIC acid is a substance that people have known by taste for thousands of years, but it is only recently that it has been thought of as anything more than the compound that makes sour milk sour. It can be made very easily and cheaply from whey or other sugar-containing agricultural by-products, and recent research has made possible new and extensive industrial uses for lactic acid

Because of the unusual structure of this acid, it may be converted into several interesting series of products. The acrylates, which belong to one of these families of compounds, have the property of forming flexible, tough, transparent substances that can be used as flexible glass or for impregnating material in moisture-proof clothing and packaging. One acrylate produced in the laboratories of the United States Bureau of Dairy Industry is a combination of lactic acid from milk and a compound from oats, thus combining by-products of two agricultural crops.

When water is removed from lactic acid, its molecules join in long chains that no longer possess the chemical activities of the simple acid. This so-called polymerized lactic acid is a resin that can be used in making lacquers and protective coatings for metal containers such as the cans used in transporting milk and those used in canning evaporated milk, vegetables, and similar products. Thus it may be substituted in some instances for metal coatings now on the restricted list. It may also be used as a glue in laminating wood and paper.

Lactic acid esters are particularly efficient solvents for many industrial lacquer resins. The slight tendency of these esters to form free lactic acid has prevented their very extensive use as solvents That fault is being overcome in research now under way.

RUBBER SUBSTITUTE

Consists of Felt Coated With Synthetics

STRIPS or die-cut pads made of a new sealing material are being used in place of priority-dominated rubber materials which were formerly used for the same purposes. The substitute consists of felt coated with a layer of any one of several different synthetic rubbers according to the ultimate purposes The resulting cushioning characteristics are similar to those of the original felt, yet the coating eliminates the absorption characteristics of untreated felt.

PLASTIC PRINTING PLATES

Save Needed Metals, Are Light in Weight

A PLASTIC lithographic printing plate, which saves from three to eight times its weight in critical aluminum and zinc, is being manufactured by The Plastolith Company from polyvinyl alcohol resin made by Du Pont

Colored maps and other military documents for the Army are made from plastic plates, and they even are used by the Army's mobile field printing units They give approximately the same number of impressions as metal plates and carry about 25 percent more ink without smudging

Polyvinyl alcohol first was coated on zinc to improve that metal's printing qualities by allowing it to carry additional ink and reducing or eliminating its grain. It developed that the actual printing was from the plastic, and that any base would be the equal of zinc and aluminum, needed in the manufacture of shell cases and airplanes.

The plastic now is not only the printing surface but also is incorporated in paper used as a base. It gives the paper required strength and stability, and readies it for a water-proof coating of another resin. Two sheets thus prepared are laminated to form the base, and the printing surface is made with a coating of polyvinyl alcohol.

Creation of the printing image is the same as with metal plates. Polyvinyl alcohol is sensitized with bichromate of

ammonia. It is exposed to light, treated with the developing ink, developed in water, etched, and placed on the press

Plastic plates used in lithographic duplicating printing weigh about one ounce, and a similar metal plate is four times heavier. For larger presses, a plastic plate 25½ by 36 inches weighs under 10 ounces and a zinc plate 4½ pounds. Thus there are large savings of space and expense in shipping and storage.

Although the Army and government take all production now, it is hoped that some plates soon will be available for the 3000 commercial lithographers who are short of zinc and aluminum To date these plates have not been used in printing newspapers.

VERSATILE GYPSUM

Finds Applications in New Wallboards and Roofs

New gypsum products developed to meet the immediate demands of wartime construction replace more critical materials, such as steel and lumber, in both temporary and permanent structures, according to Henry W Collins, vice-president of the Celotex Corporation WPB is advocating the use of such gypsum products in place of less available materials

The products include a new gypsum exterior siding covered either with smooth or mineral surfaced roofing; laminated gypsum wallboard panels suitable for demountable or permanent single-wall interior partitions, laminated gypsum roof deck slabs, and poured gypsum roof decks for use with wood frame construction

The exterior wallboards supply both structural and weather protection needs for many "Theater of Operations" buildings such as barracks, warehouses, recreation centers, and repair shops The products also are applicable to war workers' homes, dormitories, and industrial buildings They are available in ½-inch and 1-inch thicknesses finished either with smooth or mineral surfaced roll roofing. The 1-inch thickness is a two-ply, laminated product with shiplap joints along the long edges. The ½-inch thickness has square edges. Sizes are 2 feet by 8, 9, or 10 feet

Interior wallboard panels are made in 1-inch, 1½-inch and 2-inch thicknesses by laminating two, three, or four layers of gypsum wallboard. Three types of demountable partitions employing these laminated gypsum panels have been worked out by Celotex. Two are studless, non-load-bearing partitions, one of which eliminates battens at the joints. The third is a load-bearing partition, which may also be used for low partitions in high-ceiling rooms Because of their large size —4 feet wide by 6 to 12 feet long—the panels can be erected easily and rapidly.

The Celotex gypsum slab is an improved rigid type of roof deck plank. It may be used to replace wood plank or other types of unit roof desk construction. The slabs are made by laminating together two, three, or four thicknesses of wallboard to form an integral unit. The slabs are light in weight, the 1½-inch thickness weighing 6¼ pounds per square foot, and the 2-inch slab 8½ pounds Tests by an independent, nationally-recognized laboratory indicate an ample factor of safety for usual roof loads, according to Celotex. The slabs also are fireproof, rot-proof and will not twist or warp

Poured gypsum roof deck is designed for use on any type of industrial building, warehouse, garage, or hangar. It can be used on a flat roof, on a steep roof up to 45 degrees pitch, and for sawtooth and monitor construction. It is capable of carrying a live load of 35 pounds per square foot.

In building the roof deck, gypsum wallboard is nailed over joists, rafters, or purlins. On this form is laid wire reinforcing fabric over which is poured a mixture of Celotex gypsum stucco and water The stucco consists of 87½ percent of calcined gypsum and 12½ percent of wood fiber or shavings. The weight of the factory mix is 55 pounds per cubic foot. It is usually applied to a thickness of 2½ or 3 inches, including the gypsum wallboard form

TANK LININGS

Made of Synthetic Rubber Bonded in Place

A method of bonding solid sheets of Koroseal directly to the welded steel, wood, or concrete of tanks, and thus extending the application of tank linings into fields which rubber cannot handle because of physical limitations, has recently been developed. Koroseal is a plasticized polyvinyl chloride which is being used in many places where its qualities are superior to those of rubber It is a synthetic elastic material with many rubber-like properties

Principal advantage of Koroseal in tank lining is its remarkable corrosion resistance because of the inertness of its compounds to strong corrosives such as chromic and nitric acids, which have a deteriorating effect on rubber

The B F Goodrich Company declares that the Koroseal linings are the most important development now being offered in the synthetic field Research is continuing on other applications of the same material.

In announcing the Koroseal linings the company points out that the material has certain limitations both in temperature ranges and effects of various chemicals on it, and that it is essential that company engineers be furnished complete service details before the material can be recommended

Advantages of the lining are cited as follows: It can be applied in thicknesses up to and including 3/32 inches It is not subject to physical damage and pin hole leaks suffered by many corrosion-resistant paints. It will not, however, withstand physical abuse and metallic gouging. In such service an oversheating of acid resistant brick is recommended. It is more resistant to abrasion than corrosion-resistant paint films. It is readily repaired if damaged. It has high electrical resistivity and prevents current losses in electrolytic action It can be easily tested for leaks with an electric tester. It is highly resistant to oxidation, water, sunlight, and gas diffusion.

SPECIALTY RUBBER

Developed During Research on Electrical Insulators

A specialty rubber which will help meet essential war needs has been developed by Bell Telephone Laboratories as a by-product of research in insulating materials. This new material, known as

C S Fuller (right) and B.S. Biggs, chemists of the Bell Telephone Laboratories, who developed Paracon

Paracon, looks and feels like ordinary rubber, resembles it fairly closely in mechanical properties, and has important advantages for certain purposes. It has a high resistance to damage by oil or gasoline It is also better than natural rubber in resistance to heat, light, and oxidation although inferior to natural rubber in resistance to steam, alkalies, and acids. Paracon can be worked with ordinary rubber machinery. In its raw state it is highly plastic and unusually well adapted to molding into intricate shapes and to use in producing rubberized fabrics.

Paracon is particularly useful as a material for special applications where, as in the aircraft field, its combination of unique properties is required An important advantage of Paracon is that it will not compete with other synthetic rubbers for its basic raw materials since the chemical intermediates required for its production are derived by other trains of chemical processes. For its synthesis it uses two major types of intermediate material. These can be derived from agricultural products and coal products, or from coal and petroleum sources, in each case by a variety of different chemical processes. Although the equipment for manufacturing Paracon is highly specialized, it differs from that required for synthetic rubber production; consequently, Paracon can add to the present supply of rubber substitutes without interfering with the production of those already under way.

INDUSTRIAL TRENDS

WHAT'S AHEAD FOR RAILROADS?

More than half of the passenger cars on American railroads today are over 25 years old, almost half of the freight cars are over 20 years old; the number of locomotives in service has steadily declined for several years. This is the picture of the present, and it presages a trend in American railroading that will zoom sharply when the necessary shackles of wartime restrictions are removed.

Fortunately, for the railroads, the Interstate Commerce Commission has recognized the fact that the roads cannot replace equipment when such great demands are being placed on raw materials by the needs of war. Thus the Commission has granted to the railroads permission to allocate funds for maintenance, even though the money is not spent until after the war. This is only common sense, when the work that the railroads are doing in the war effort is taken into consideration. And it is applied common sense that will have a far-reaching effect on many industries after the war is over.

Through more efficient use of equipment, quicker turn-arounds, higher speeds, and heavier loadings, the railroads have been able to carry their full share of the wartime burden. Equipment does wear out, however, and even faster under stress. Thus, although constant repairs are keeping as much rolling stock in service as possible, post-war times will see a great demand on suppliers of railroad equipment. When this time comes, many heavy industries will be kept busy for a long time furnishing the railroads with new material in the form of improved rolling stock that will be lighter, faster, more efficient than heretofore.

UNDERGROUND "BUILDINGS"

Based upon sound engineering principles is the proposal to locate a commercial air base in the rock of the Palisades, across the Hudson River from New York City. Here could be excavated huge caverns of relatively constant temperature that would contain hangar rooms, garages, restaurants, offices, waiting rooms, and so on. The material excavated would be dumped into the river to provide the necessary base for landing fields and ship docks.

This scheme has little of the fantastic linked with it. The facilities—compressed air drills, drill steel, dynamite, power shovels, trucks—are available. The construction of such an air base would bring to New York a close-in port without using land that would be valuable for other purposes. If started now it would provide ideal air-raid shelter facilities. After the war it would be one more advantage to the air-borne commerce that is bound to come.

There are many other locations in the country where similar projects would be advantageous and feasible. Perhaps here is a trend in engineering and aviation that someday, through someone's foresight, will mark the beginnings of a step forward in overcoming some of the difficulties that aircraft are heir to in their requirements for landing and storage space.

Parenthetically, it should be noted here that there have been persistent rumors of similarly constructed airports in Europe, concealed for military purposes.

THE FEMALE INFLUENCE

Post-war problems must, of necessity, creep constantly into this page. A recent one, and one that cannot be overlooked by those who are most concerned with consumer markets in after-the-war days, is the increased influence that women are going to have in the purchase of many products pertaining to the everyday lives of average citizens. There are millions of women who, drawn from all walks of life including the housewife, are today performing work in industry. These women are getting the feel of the mechanical. They are finding some of the advantages that accrue from the use of automatic machines, advantages that, their well-known intuition will tell them, can be translated into terms of easier work in the home.

Thus the woman who has been running an automatic machine in an air-conditioned factory is not going to be satisfied, in post-war days, to go back to the drudgery of the broom, the coal shovel, and the washboard. She is going to demand, and rightly, too, the same conveniences in her home that she had in the factory. Faced with such a fact, the appliance manufacturer who ignores the feminine influence in the future, or who deprecates its importance in the buying field, is going to find that he has missed the significance of an important trend in his field.

RADIO-ELECTRONICS

In shaping the trends of the relatively new science of radio-electronics, we can do no better than to quote from a recent statement by David Sarnoff, president of RCA. "When peace shall have come," says Mr. Sarnoff, "radio promises to electronize the industries of peace as it has electronized instruments and industries of war. . . . Radio instruments will emerge from the war almost human in their capabilities. They will possess not only a sense of direction, but a sense of direction that will open new avenues of service. The radio direction finder, which heretofore had only an ear, now also has an eye. . . . American inventive genius contributed much to the creation and perfection of the great offensive and defensive weapon known in the United States as Radar. The word means radio detecting and ranging. . .

"Although we must first serve the present—lest there be no future—it is our duty," says Mr. Sarnoff, "to look beyond the horizon of war to survey our task in helping radio to meet its post-war responsibilities."

YOU, TOO, CAN FLY

If there is one development of the present war that has caught the public imagination it is aviation. And, without doubt, this same development is going to become a commonplace in the lives of many during peace-times. To this end there is continuing research on the development of the small airplane that will have present applications in the emergency of the day as well as implications for the future.

It is not surprising, then, that plane manufacturers have at least part of an eye fixed on the future, and that they are planning for the day when the average American will yearn for a ship that will carry him through the air with the same comfort and convenience and safety that his present motor car carries him over the earth-bound road. A recent prospectus from a light-plane manufacturer says—and the statements are linked definitely with present aviation progress—"The dependable, easy-to-fly airplane has brought the fun of flying within the reach of everyone. You don't have to be a superman to fly one of these ships, for they can be flown by anyone in average good health who is capable of exercising normal judgment."

WINDOWLESS WALLS

There are several large factory buildings in the United States today which have been constructed without windows, depending entirely upon man-made air conditioning and illumination for the factors that influence human comfort and working ability. In one recently constructed plant of this nature, the walls, of brick, are designed to "breathe," thus preventing condensation of moisture and keeping the walls dry, important factors in completely closed buildings. The "breathing" is made possible by construction methods that form a tile flue in the walls, thus not only admitting air but also contributing to the insulating value of the wall as a whole.

Since the windowless factory is a relatively new development in building design, such work as this will have important implications on future construction.

—*A. P. Peck*

Ultra-Violet—Near, Middle, Far

Many Industrial and Personal Uses Are Being Made of the Phenomena Surrounding these Radiations

LAWRENCE C. PORTER
Engineering Department, General Electric Company, Nela Park

THE ADVERTISING sections of current publications show that there is quite a variety of so-called sun lamps varying in cost from about \$3.50 to approximately \$100 for home use, and up to several hundred dollars for physicians' and hospital type units. Most of these are sources of ultra-violet radiation of one kind or another. Some are of value in maintaining health, some are particularly suited for treating disease, and some are of little or no value for either purpose though they may be useful in other fields for stimulating certain luminescent materials and causing them to glow in the dark.

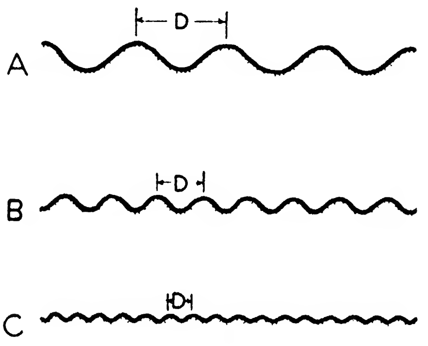
The selection of the proper lamp for any specific purpose without knowledge of the physics of radiation is difficult. It is complicated because there are ultra-violet lamps that produce reddening of the skin—thus giving the appearance of ordinary sunburn—and therefore are assumed to be of health benefit similar to summer sunshine, but which actually may even be detrimental to that purpose. The problem is further complicated by the fact that many artificial sources of ultra-violet emit a combination of several forms of ultra-violet radiation.

If a large boulder is rolled into a pond of still water it will cause a big splash and set up several large waves, separated by perhaps several feet, that chase each other across the pond. These might be represented as at A in the central drawing on this page. If instead of the large boulder we throw into the pond a good size rock, similar waves are set up but they will be smaller and closer together, as represented at B. Now suppose we drop a little pebble into the water. Still smaller and less widely separated waves are set up, represented at C. All three of these illustrations are water waves, but of different wavelength, that is, distance from the crest of one wave to the crest of the next, as indicated by D.

This is a very simple analogy to ultra-violet radiation, which also consists of waves, but instead of travelling across the surface of water they travel through air. They, too, are of different wavelength. The longer ultra-violet waves are known as near ultra-violet, the medium ones as middle ultra-violet, and the shorter ones as far ultra-violet. Actually their wavelengths, instead of being measured in feet or inches, as with water waves, are a very small fraction of an inch, varying from approximately .0000147 of an inch for near ultra-violet, and 0000118 of an inch for middle ultra-violet, to 0000101 of an inch for far ultra-violet.

As a matter of convenience, such very short waves are measured not in inches but in what are known as Angstrom Units, variously abbreviated as "A U", "A°", or "λ". One λ equals 000000004, or $\frac{1}{250,000,000}$ of an inch. The near ultra-violet waves center at 3660λ, the middle at 2967λ, and the far ultra-violet at 2537λ.

Sources emitting any of the above wavelengths also emit both longer and



Wavelength, indicated by D, determines the characteristics of radiations

shorter waves than the central ones. At just what wavelengths the ultra-violet passes from near to middle to far is not a definite figure. In general, however, near ultra-violet is usually considered to cover the range from 4000λ to 3200λ; middle ultra-violet from 3200λ to 2800λ, and the far ultra-violet from 2800λ to 2000λ. There are ultra-violet waves shorter than 2000λ but they are rapidly absorbed by air and can, therefore, for most purposes, be disregarded.

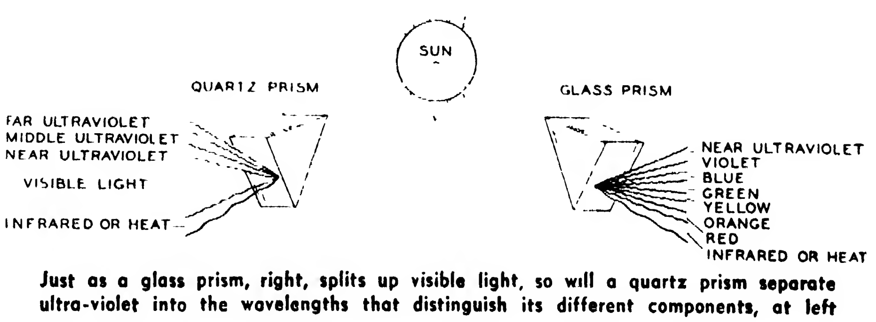
The sun emits ultra-violet over the entire range but the layer of ozone above the earth absorbs practically everything shorter than 2900λ, and ordinary window glass transmits very little if any radiation shorter than 3200λ.

As a matter of general interest the ultra-violet waves form a very small portion of the entire electro-magnetic spectrum. This entire spectrum contains waves of infinitely short lengths to waves that are a mile or more in length. The relative position of the ultra-violet waves in the spectrum is shown by the following tabulation:

Cosmic waves—extremely short
Gamma waves
X-ray waves
Ultra-violet waves
Visible light waves
Infra-red waves
Radio waves—very long

Without going into the physics of the generation of ultra-violet radiation by artificial sources, it is sufficient to say that the passage of electricity between two pieces of carbon, as in the carbon arc lamp, or through mercury vapor in a quartz tube, as in the modern sunlamp, generates ultra-violet radiation over the entire range of wavelengths from the near to the far ultra-violet. For the purpose of study—measurements of the relative amounts of energy of different wavelengths and experimental work on the effects of various wavelengths—they can be separated by passing them through a quartz prism. The effect of a quartz prism on ultra-violet is similar to that of a glass prism on visible light. We all know that a glass prism placed in a beam of sunlight will break up the beam into the different colors of the spectrum. The various colors are produced simply by a difference in wavelengths. Similarly, what differentiates near, middle and far ultra-violet is wavelength. A quartz prism separates the various ultra-violet waves as a glass prism separates the various waves of visible light.

IT WILL be noticed that a quartz prism is used for ultra-violet and a glass one for visible light. Ordinary glass will transmit very little of the middle ultra-violet and none of the far. There are, however, certain special glasses, in composition and hardness between ordinary window glass and quartz, that do transmit ultra-violet of the shorter wavelengths. By selecting the proper type of glass we can select the radiation wavelengths or kind of ultra-violet we wish to use and screen off that which we do not desire. The modern sunlamp designed for health purposes has a bulb of one of these special glasses surrounding the small quartz-tube mercury arc which generates the ultra-violet. The composition of the glass is such that it transmits readily the middle ultra-violet, or so-called "health rays," and



Just as a glass prism, right, splits up visible light, so will a quartz prism separate ultra-violet into the wavelengths that distinguish its different components, at left

screens out the far ultra-violet which is of no known health value (other than the treatment of disease and the killing of germs) and is injurious to the eyes.

Of the principal uses of near, middle, and far ultra-violet, probably the most commonly known use is the effect of near ultra-violet on the photographic film and plate. It is the near ultra-violet in day-

Middle ultra-violet, supplied by ceiling-hung lamps, stimulates colesterol in the skin to create vitaman D to produce strong bones and to prevent or cure cases of rickets

light that is used in taking pictures Fortunately, the near ultra-violet is readily transmitted by the glass of our windows, camera lenses, and so on

Another application of near ultra-violet which has been used for display purposes and the production of theatrical effects for years—and is now being used to some extent for signs, markers, guide lines, and so on, during blackouts—is the stimulation or charging of certain chemicals so that they start and continue to glow in the dark That phenomenon is known as phosphorescence There are other substances that glow only while they are being activated by near ultra-violet That is known as fluorescence When the visible light is filtered out of sources of near ultra-violet by means of certain black near-ultra-violet transmitting glasses, a resulting radiation is obtained which is popularly termed "black light"

Of the many photo-chemical and photographic effects of the near ultra-violet, two are of current interest. The near ultra-violet, as available from fluorescent sources, is uniquely suitable for catalyzing the chlorination of certain gases used in the preparation of synthetic rubbers. In a somewhat similar way the near ultra-violet is being used to clear up remaining traces of hydrogen from electrolytically produced chlorine, the hydrochloric acid formed being readily removable.

The middle ultra-violet is that range of wavelengths which is absorbed by a substance near the surface of our skin known as colesterol. This substance, under the stimulation of middle ultra-violet, creates vitamin D which the blood distributes throughout our bodies The vitamin D assists the utilization of calcium and phosphorus to produce strong bones and teeth and prevent or cure rickets. This middle ultra-violet, if used in sufficient quantity (either a light dosage and a long exposure or a strong dosage and a short exposure), produces reddening of the skin—that is,

Germicidal lamps, producing ultra-violet, are being used in surgical and dental instrument sterilizing cabinets

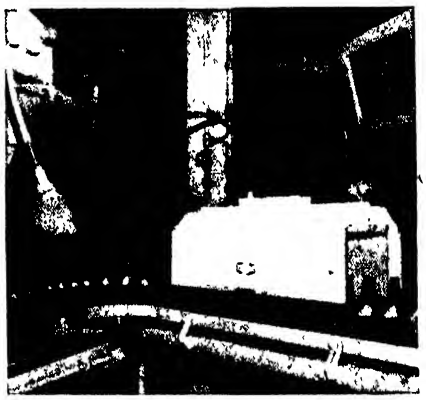
sunburn—technically known as erythema, and if carried far enough results in blistering and peeling

There is no known value in far ultra-violet for the maintenance of general health In fact, there may be some reduction of the benefits of middle ultra-violet when far ultra-violet accompanies it Unfortunately, perhaps, far ultra-violet will also redden the skin, or even cause peeling, though it seldom causes a blister This reddening often misleads those using a lamp generating far ultra-violet to believe that they are receiving health benefit, and it assists in selling certain cold quartz type lamps for health purposes that probably are of little if any good for such purposes.

However, there are certain powerful quartz arc lamps in common use in doctors' offices which, in addition to the far ultra-violet, emit so much middle ultra-violet that they are of very definite health benefit.

The chief function of cold quartz lamps and of the germicidal lamps and Sterilamps is the destruction of bacteria. Such lamps are useful for treating various skin infections, but should be so used only under a doctor's direction. They are most useful for irradiating the upper air in locations where people are close together for several hours at a time. Under such conditions many types of germs are breathed into the air and float about much as does an odor or smoke. Far ultra-violet radiation will kill most such air-borne germs and thus lessen the danger of the spread of such contagion as measles, chicken pox, mumps, scarlet fever, diphtheria, meningitis, small pox, septic sore throat, whooping cough, and so on

There are already thousands of germicidal lamps in use in hospitals, and their use is being extended to surgical and dental instrument cabinets, schools, offices, barracks, factories, ships, and even to the home It must be remembered, however, that the short-wave ultra-violet can cause very sore eyes—conjunctivitis—and peeling of the skin. The practice in using



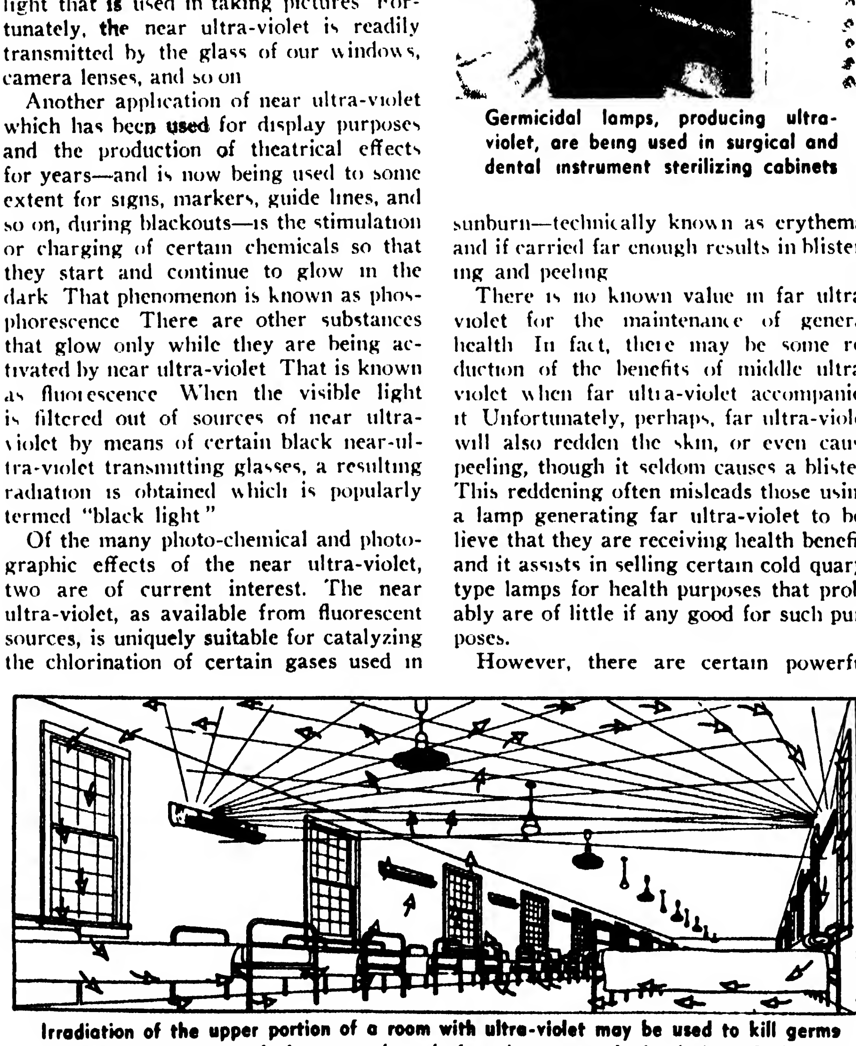
Growth of fungus in bottled goods is retarded by use of ultra-violet rays

such lamps, therefore, is to confine all radiation to areas above the eye level. Fixtures for such lamps are especially designed to accomplish that end

Considerable research work is under way to determine the effectiveness of far ultra-violet or short-wave ultra-violet radiation in controlling the spread of respiratory diseases among poultry and cattle.

There are many industrial uses of the far ultra-violet which take advantage of its germicidal and fungicidal effects. It has recently become a standard way of disinfecting the air in blood bank and serum processing laboratories. It provides an economical way for the essential reduction of the thermophilic bacteria in sugar used for canning. It is used for its fungicidal effects on pre-mixed baker's flour and in bottling plants.

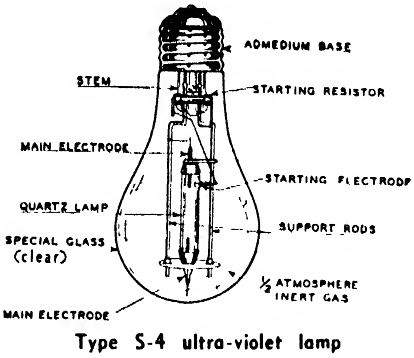
The selection of an ultra-violet lamp depends largely on the purpose for which it is intended. If black-light effects are the prime requisite, a lamp having the major portion of its output in the near ultra-violet range should be selected. Well



Irradiation of the upper portion of a room with ultra-violet may be used to kill germs in the lower portion of the room through forced or natural circulation of the air

suited to that purpose are the 100-watt mercury-arc lamps, H-4 type. They require a transformer for operation and a black ultra-violet transmitting glass filter.

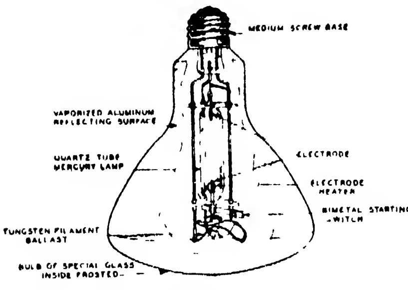
If a sunlamp is desired for human health purposes, or for use in chicken houses or dairies, the type S-1, S-4, RS-4, and RS lamps are most suitable. With the exception of the RS lamp these also require a transformer and a suitable fixture. The types S-1, S-4, and RS-4 lamps all have about equal ultra-violet output. For



Type S-4 ultra-violet lamp

the average person a 10 minute daily exposure at a distance of approximately 2½ feet from the lamp is sufficient, though the exposure may be increased or the distance shortened, or both, as one becomes accustomed to the ultra-violet, just as one may gradually increase exposure to mid-summer sunlight.

The RS-4 sunlamp is essentially the same as the S-4 except that no external



Type RS sunlamp is provided with an internal aluminum reflector

reflector is necessary, the bulb itself being coated with reflecting material on the inside. These lamps are both 100-watt units.

The S-1 sunlamp has the same ultra-violet output as the S-4 group, but about four times as much infra-red, or heat, as it consumes 400 watts instead of 100.

The RS sunlamp is the latest of the sunlamp group. This lamp consumes 275 watts and is also in a reflector type bulb. Its ultra-violet output is somewhat less than that of the S-1 or S-4 lamps, but this can be compensated for either by longer exposures or by shorter exposure distance, or both. This lamp has the outstanding advantage of operating directly on 110-125 volt A.C. lighting circuits without the use of a transformer. The lamp bulb contains a ballast resistance and automatic switch taking the place of the transformer required by the other lamps. Due to war conditions the RS lamps are not now in production.

Thus continuing research has developed a number of convenient ultra-violet sources and is finding new uses for them in both routine work-a-day applications in industry and in the fields of personal health. Much of the work being done with ultra-violet must remain untold for the duration, yet sufficient is already known to serve as a basis for constructive thinking toward post-war commercial developments.

•

Editor's Note: Readers who have industrial problems which might be solved through the application of ultra-violet radiation are invited to address specific questions to the Editor for forwarding to the author of the foregoing article.

• • •

ELECTRONICS MYSTERY

Solved, May Lead to Improved Vacuum Tubes

THE DISCOVERY that gas dissolves in certain metals just as salt dissolves in water may lead to the production of longer-lasting electronic tubes which will require less power to operate, Dr. Harvey C. Rentschler, noted physicist, recently told a meeting of the American Physical Society. Dr. Rentschler, who is Director of Research for the Lamp Division of the Westinghouse Electric and Manufacturing Company, reported the results of his experiments to unravel one of the unsolved mysteries of electronics; namely, how tiny particles of matter called electrons are emitted from metals to set up a flow of current inside such tubes as those for radio and X-ray.

Experiments during the last eight years have led to the conclusion that atoms of gas—oxygen, hydrogen, or nitrogen—actually dissolve in the crystalline structure of some metals just as salt dissolves in water. These gas particles then "loosen" the electrons in this structure, causing them to be emitted from the metal more readily when heat or light is applied.

"This explanation," Dr Rentschler declared, "should result in longer-lasting tubes and accomplish important savings in the size and number of electric batteries, generators, and other apparatus needed to supply the filament power. Such improved tubes would be the result of better 'cathode' construction," he continued. Cathodes are the metal filaments inside tubes which fire a stream of electrons at speeds greater than a million miles an hour. The emission of electrons from metal cathodes is the basic principle of all electronic phenomena. As these tiny particles of negative electricity pass from the cathode to a metal plate, called the anode, they set up a flow of electric current which is put to work to accomplish countless tasks.

Dr. Rentschler first discovered, in 1935, that a small amount of oxygen reacting with such metals as thorium, uranium, and barium speeded electron emission, but found that a similar effect was not obtained with such commoner metals as iron, nickel, copper, zirconium, titanium, and others. "Using a pure form of zirconium, titanium, and hafnium," he explained, "we now have found that these metals, too, are likewise affected by oxygen as well as nitrogen and hydrogen.

"When these metals in a pure state and mounted on a core of tungsten are heated in a vacuum, they will melt into a soft globule. When the pure metal is heated in oxygen, hydrogen, or nitrogen at a low temperature and then at a still higher temperature in a vacuum, it becomes brittle and hard.

"After an appreciable amount of gas is 'dissolved' in the metal and all excess gas removed, the metal can be heated to temperatures as high as 2700 degrees, Fahrenheit. The fact that there is no pressure increase in the vacuum tube shows that no further gas is liberated. The gas apparently dissolves uniformly to form what we call a 'solid solution' in the metal. From such metal can be made excellent cathodes."

Although scientists have known that oxide-coated cathodes emit electrons more readily than cathodes of plain metal, they have been unable heretofore to use oxides for high voltage tubes, Dr. Rentschler pointed out. This is because the high voltage sets up such a strong electric field that the oxide-coating is torn from the surface of the metal. Such a coating consists of a paste baked onto the metal.

By dissolving gas into the metal, however, it may be possible in the future to produce an oxide-coated cathode for high voltage tubes, he continued. The oxide in this case becomes an integral part of the basic cathode metal and cannot be torn off by the strong "pull" of the electric field.

MOLECULAR ATTRACTION

The Essential Difference Between Fibers, Plastics, and Elastomers

THE DIFFERENCE between a springy rubber-like substance and a hard plastic or a tough fiber, either synthetic or natural, lies in the tendency for the molecules of these substances either to contract or to form crystals, Dr. H. Mark, professor of organic chemistry at the Brooklyn Polytechnic Institute, recently reported to the Society of Sigma Xi.

The more crystallization in its structure the more the substance becomes a typical fiber, such as nylon, silk, cotton, or rayon. If the mutual attraction between the chain-like molecules of a given material is low, then it will show mainly the properties of an elastomer such as rubber, Buna S, Neoprene, Hycar, Butyl rubber, and so on. This is also true if the molecules do not fit well into a regular three-dimensional lattice structure.

In between these extremes, the substance will show the properties of a plastic, such as hard rubber, methacrylate (Lucite), vinylite, polystyrene, or ethyl cellulose.

Present experimental knowledge shows that all of these substances have about the same fundamental structure, but it is their ability to crystallize that gives them different properties.

All types of what the chemist calls "high polymers," whether they be rubbers, plastics, or fibers, have the same high order of polymerization, that is, their molecules are composed of about 2000 or more atoms.

Anthropocentrism's Demise

New Discoveries Lead to the Probability that There Are Thousands of Inhabited Planets in our Galaxy

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

We told last month of the discovery that three stars among our nearest neighbors are attended by invisible companions, which are much less massive than any bodies that had previously been detected outside the solar system. The smallest mass so far known, in the case of a star which can be seen by its own light, is about one sixth that of the Sun; the new discoveries have masses from one fifth to one twentieth of this

This raises a question of great general interest. Are these bodies stars, or planets revolving about the visible stars which they accompany? More precisely, which of the two names do they properly deserve?

This is a matter of definition, and we must be guided, as in all such cases, by past usage, so far as this is relevant In our own system, this usage may be expressed in the working definition: A planet is a compact, opaque body in orbital motion about the Sun, and shining by reflected light.

The words "compact" and "opaque" are introduced to distinguish between planets and comets, which are diffuse and practically transparent swarms of matter, while planets have definite boundaries—which gravitation compels to be nearly spherical, with some flattening by rotation.

So long as these conditions are met, a body may be called a planet no matter whether it is solid, liquid, or gaseous Question might theoretically be raised about a mass of pure, "permanent" gas, free from all constituents which might condense to form clouds; but all gases scatter light, and hence obstruct its passage, and it is easy to show that a purely gaseous mass, held together by its own gravitation, and as much as 5000 miles in diameter, would be effectively opaque except at the very edge. The word opaque might, therefore, have been omitted from our definition.

One limitation remains—that of shining by reflected light. This demands that the surface of the body shall not be hot enough to shine on its own account; but this can be interpreted in two ways: first, that the body could not be seen by its own radiation by the human eye, if it stood alone in perfect darkness, and second, that any feeble light which it might emit on its own account would be overwhelmingly surpassed by the sunlight which it reflects.

The writer owes to Dr. Babcock, of Mt. Wilson, the interesting observation that the temperature at which a cooling body ceases to be visible to an observer who has rested his eyes thoroughly in complete darkness is a little above 400 degrees, Centigrade, or about 700 degrees on the absolute scale. The permanently sunlit side of Mercury is almost as hot as this; but, considering the intense illumination of the planet by the Sun, it would be ridiculous to speak of it as self-luminous.

It may be recalled that it was once (mistakenly) believed that Jupiter and Saturn might be hot up to their surfaces, so that they might be feebly self-luminous if seen alone, but no one objected to calling them planets on this account

At one point past usage gives us little help How big would a dark body have to be to lose the right to be called a planet? All that can be said is that, before it was known that the companion of Algol was perceptibly luminous, the star's variation was sometimes described as "due to eclipses by an enormous planet," with very little protest—though this could hardly be called established usage.

Now let us turn from words to things—and see what may reasonably be concluded about the properties of the newly discovered bodies from the available information—taking as an example the faint companion C in the system of 61 Cygni for which the data are best.

The only thing we *know* about this body is that its mass is 0 016 times the Sun's, but we may reasonably assume that, like the two visible stars in the system, it is of normal composition, consisting mainly of hydrogen and helium, with a few percent of heavier atoms. The two main questions which we want to answer, if we can, are: "How big is this body?" and "How hot is its surface?"

The first question is hard. We can, however, set a definite lower limit, by assuming that the body has contracted to the smallest size which the laws of nature permit. Here we find a curious situation. In a large mass, comparable with the Sun's, this limiting condition is one in which the matter is "degenerate" and has an enormous density—as actually occurs in white dwarf stars, such as the companion of Sirius. In this state the relation of internal pressure and density are such that stars of large mass, when they settle down, are not merely denser, but actually smaller in diameter, than those of smaller mass. Bodies of the Earth's mass or less settle down into the familiar, non-degenerative, state in which the large masses have a slightly greater mean density, on account of the greater internal pressure, but are of larger radius than smaller masses of the same composition. Bodies of intermediate mass reach, at their limit, a partially degenerate state; and (for a given composition) there is a certain mass which has a maximum radius, larger than for either greater or smaller masses. The difficult theory of this has been worked out approximately by the Indian physicist, Kothari, for bodies composed of but one kind of atom His results for helium may be adopted as the best guide For the maximum size, in a completely "cold" state, the mass comes out twice that of Jupiter, and the diameter 55,000 miles--somewhat smaller than Saturn Our body has eight times this mass. Its limiting diameter comes out 45,000 miles, with a mean density of 150 times that of water. This is high, but only about 1 percent of that of a typical white dwarf

The diameter of the bright star about which C revolves may be rather closely estimated as 0 6 of the Sun's, or 520,000 miles C is, therefore, certainly as large, in comparison to its primary, as Saturn in comparison to the Sun.

It is possible that C is in this limiting state (for several normal stars have degenerate companions); but it is probably more likely that C is not degenerate. It would be well clear of degeneracy if its density were equal to the Sun's—in which case its diameter would be 216,000 miles, or 40 percent that of its primary—pretty big for a planet, but passable.

There is no assignable reason, however, why C should not be ten times as large as this. If it were more than ten times the Sun's diameter, the attraction of the primary would raise such huge tides on it, when they were closest, as to make its stability uncertain; but there is a great range of possible sizes within which we have no present basis for making any decision.

The other main question, of surface temperature, is capable of a more definite answer; but before we take this up we must consider the internal temperature and constitution of the body.

In the limiting case of smallest diameter, the answer is explicit; the body would be completely cold, inside and out. However, for a diameter only a little larger, both the internal and the surface temperatures should be fairly high (compare the companion of Sirius). A good idea of what to expect can be derived from the case of density equal to the Sun's. If we assume that the internal constitution and composition resemble the Sun's, the central temperature comes out 1/16 of the Sun's, or 1,600,000 degrees; and any plausible assumptions make it several hundred thousand degrees.

At such temperatures, the *internal* con-

stitution of the body would resemble that of a star. The atoms would be heavily ionized, the resulting gas highly compressible, and the general theory of stellar constitution, now well established, would be applicable.

In particular, the situation is within the range of Morse's tables which make it possible to calculate the rate at which heat would escape from the interior to the surface. Applying these (assuming composition similar to the Sun's), it is found that the whole radiation of heat would be only 1/140,000,000 as great as the Sun's. The surface temperature required to maintain this is 105 degrees above the absolute zero, or —168 degrees, Centigrade.

In such a body, though it had an intensely incandescent core, heat would leak outward so slowly that the surface would be exceedingly cold, and covered, like that of Jupiter, with thick layers of clouds formed by the condensation of substances such as ammonia which, at the temperatures familiar in every-day life, are gaseous. Below these clouds would be others—for example, of condensed water in regions of somewhat higher temperature. Only at a depth of thousands of miles would the gases be hot enough to be free from condensed vapors

These outer cloud-layers would be so opaque that the heat which flowed toward them through the clear gases below would be carried onward, not by radiation from atom to atom, but by convection—bodily transport by ascending currents of hotter gas, matched elsewhere by descending currents of gas which had cooled When condensation is taking place, liberating latent heat, this is a powerful mode of heat-transport.

The cloudy layers, however, must form but a small fraction of the mass of the whole body, and the main flow of heat would come from the gaseous interior There might be important convection currents in this if (as is very probable) electrons and highly charged atoms, dissociated at great depths, combined in higher regions of lower temperature The net transport of heat by such currents might exceed that carried by radiation even in the clear gas; but, if it were a hundred times greater, it would suffice only to maintain the outer surface at about 320 degrees, absolute, or 50 degrees, Centigrade

It appears, therefore, to be an entirely safe conclusion that this small body, if of the density of the Sun, cannot be self-luminous to even the feeblest degree. A body of greater diameter would be cooler, inside and outside, a smaller one hotter Therefore it is entirely safe to conclude that 61 Cygni C is *a dark body* in the strictest sense of the words.

We have still to inquire whether the body would reflect enough light to be a respectable planet. As it is almost certainly cloud-covered, its reflecting power should be comparable to that of Jupiter At the mean distance of 2 4 astronomical units from the bright star, a body of 1/10 the Sun's radius, if attendant upon the brighter component of the pair, would reflect as much light as Saturn does from the Sun; if near the fainter component, about half as much This is certainly enough to make it a very respectable planet Even with the minimum possible size it would still be a conspicuous object if viewed from planetary distances such as occur in the solar system

Seen from the Sun's distance, the companion would appear fainter than the 24th magnitude—that is, less than a tenth as bright as the faintest star observable with the 100-inch telescope There is, therefore, no hope of observing it directly —even if it were not drowned out hopelessly by its primary star which is millions of times brighter.

Summarizing our results, we may conclude that the newly discovered object is a dark body, but shines by reflected light more strongly than most planets in our own system We would have no hesitation in calling it a planet, if it were not for the chance that it may be larger in diameter than the bright star around which it revolves

Noteworthy as this discovery is from the technical standpoint of astronomy, it is much more so from the general one of philosophy Recent observations, especially of double stars, have detected many more "invisible" companions - most of them larger in mass, compared with their primaries, and doubtless faint *stars* which would be directly visible but for the glare of these neighbors Such faint companions are evidently very numerous among the stars as a whole, and, the more our means of observation are refined, the smaller are the masses which we can detect Very small attendants produce so small an oscillation of their primaries that it can be detected only when the latter are among the nearest stars All three of those which we have been considering are within five parsecs (or 16 light-years) from the Sun Within this distance there are probably less than 200 stars, only a decided minority of which have yet been adequately observed to detect companions, if they exist

It is, therefore, clear that the number of stars which are attended by dark companions must be a respectable percentage of the whole Among the hundreds of millions of known stars, there are probably millions of such bodies Whether there are still smaller ones, comparable in mass to Jupiter, or even to the Earth, we can not find by direct observation, even on the nearest stars, but there is no sign that the number of companions falls off as they get smaller, down to the observable limit

On the basis of this new evidence, it, therefore, appears probable that, among the stars at large, there may be a very large number which are attended by bodies as small as the planets of our own system This is a radical change—indeed, practically a reversal—of the view which was generally held a decade or two ago The older opinion, that planetary systems are excessively rare, was a deduction from the then accepted theory of the origin of the solar system by a close encounter, if not a collision, between the Sun and another star Such encounters must be extremely rare. More recent theoretical work—especially that of Spitzer—has created grave doubt regarding the validity of this theory, and we are completely in the dark regarding the origin of the planets But now, in place of a deduction from a doubtful theory, we have a moderate generalization of newly discovered facts. Small companions exist, in abundance, down to, if not beyond, the limit at which any one would call them planets, and there is no known reason why smaller planets should not exist in comparable numbers

Such bodies would doubtless be similar in chemical composition to the planets of our system, as the stars are to the Sun Under the operation of general physical laws the larger ones, down to about ten times the Earth's mass, would contain great quantities of hydrogen and its compounds, like our major planets Those comparable to the Earth in mass could not retain these light gases, and would be spheres of rock surrounded by atmospheres and with more or less water on their surfaces Smaller bodies would be atmosphereless, like the Moon

Among the planets of intermediate size, some would be at such a distance from their primaries that they were maintained at temperatures at which water was liquid, at least during some seasons of the year All such bodies would be essentially habitable—capable of supporting life of the same *general* nature as exists on earth The number of planets which satisfy these conditions, though no large fraction of the whole, may, in the aggregate, be very large

If, as appears to be probable, vegetation exists on Mars, life has developed on two out of the three planets in our system where it has any chance to do so With this as a guide, it appears now to be probable that the whole number of inhabited worlds within the Galaxy is considerable To think of thousands, or even more, now appears far more reasonable than to suppose that our planet alone is the abode of life and reason

What the forms of life might be on these many worlds is a question before which the most speculative mind may quail. Imagination, in the absence of more knowledge of the nature of life than we now possess, is unequal to the task There is no reason, however, against supposing that, under favorable conditions, organisms may have evolved which equal or surpass man in reason and knowledge of Nature—and, let us hope in harmony among themselves!

It may fairly be claimed, then, that this latest discovery completes the work which Copernicus began four centuries ago Though the belief that our world was the material center of the Universe has long been dead, the supposition that it was (at least probably) unique in being the abode of creatures who could study the Universe has lingered long Now this last stronghold of the old way of thinking has fallen, and there is no longer a basis for supposing that either this world or its inhabitants are unique, or in any way the "first, last and best of things" The realization of this should be good for us *—Manitou Springs, Colorado, April 22, 1943.*

Can Colds Be Prevented?

There is no Effective Method for the Prevention of the Common Cold—Not Vaccines, Not Vitamins

ROBERT H. FELDT, M.D

You might as well take so many hypodermic injections of water as to take cold vaccine shots. Neither will do any good in the prevention of colds. Nor will vitamin capsules help These conclusions are based on a critical review of medical literature. A member of the Council on Pharmacy and Chemistry of the American Medical Association recently stated that "at present there are no effective methods available for the prevention of the common cold."

When cold vaccines were first developed, glowing reports appeared. In one large factory, cold shots were given to every employee through an entire winter. The workers almost universally stated that they had fewer colds than they had noticed the year before Other doctors reported similar results with their patients.

Dr Alphonse R. Dochez, Professor of Medicine at Columbia University, was not satisfied with this kind of evidence He thought it was unfair to judge a vaccine by comparing the frequency of colds during the season when the vaccine was being administered with the experience of the preceding year. He recognized the well-known principle that the controlled experiment is the only accurate way to evaluate a new therapeutic method A group of persons taking treatment should be compared with a similar series of control subjects who receive no therapy.

Dochez and his assistants gave cold vaccine injections weekly to 20 infants. Twenty other babies of similar age and sex were observed during the same period of time. All 40 children lived under the same roof and their care was identical. Those who received the vaccine had just as many colds as the ones who didn't.

Colds were once thought to be due to infection of the respiratory passages with various kinds of germs Therefore, vaccines were developed containing millions of dead germs of these kinds. An immunity against germs of the type found in the vaccine was supposed to develop as a result of the injections. Recent investigation has established that germs of the sort used in vaccines are not the cause of colds and it is no wonder that the vaccines have been ineffective.

Drs. Harold S. Diehl, A. B. Baker, and Donald W. Cowan, of the University of Minnesota, are famous for their research with colds. They have tried numerous forms of treatment, but they agree with other doctors that the most important step in controlling colds lies in the direction of prevention. After years of experimentation, they report that they have been unable to find an ideal preventive method

The subjects for their studies have been volunteers from the student body whose history showed that they were unusually susceptible to colds. Only students in robust health were selected. The doctors did not wish the results to be influenced by the inclusion of persons who suffered from sinusitis, asthma, or other chronic diseases of the respiratory organs.

One half of the students who entered the "Cold Prevention Group" were given weekly or biweekly hypodermic injections of the vaccine. The other half received injections of water and unknowingly acted as control subjects. The students who were given the water placebo were under the impression that they were getting cold vaccine. Altogether more than 700 people participated in the study.

The subjects who took the cold shots had an average of 1.7 colds during the school year. Those in the control group whose only medicine had been an injection of sterile water had an average of 1 8 colds. For practical purposes, such a difference can be ignored. The number of school days lost due to colds was exactly the same in the two groups Complications such as pneumonia and sinusitis were just as frequent among the vaccinated as they were among the unvaccinated.

When the students registered for the cold prevention program in the fall, they reported the number of colds they had experienced the previous winter. On the average, their history showed more than five colds a year. While taking the injections of vaccine or water, they had less than two colds a year—a reduction of more than 60 percent.

These figures emphasize the fallacy of trying to judge the value of therapy unless the experiment is controlled. It would be as logical to conclude that injections of water prevented colds as it would be to infer that the beneficial effect was due to the vaccine. Each group showed the same degree of improvement. It is obvious, therefore, that the vaccine was not responsible for the remarkable reduction in the number of coids.

Several factors probably account for the decreased frequency of colds. Careful examinations and accurate reports were secured during the year of observation, and the number of colds experienced is a matter of record. The history cards for the previous year were filled out from memory and there may have been some subconscious exaggeration. Perhaps the students remembered to take better care of themselves because of their visits to the clinic for a shot in the arm. This frequent reminder that they were trying to prevent colds may have prompted them to avoid people with colds, secure plenty of rest, and dress warmly.

The Minnesota doctors were sometimes mildly embarrassed by inquiries from practitioners throughout the state. A physician wrote: "John Olson, who is teaching in our high school, was at the University of Minnesota last year. He had such excellent results with the cold vaccine you gave him that he would like to have me give it to him this year. Will you please tell me where it can be secured?" As likely as not the material that gave such "excellent results" was water. At the last convention of the American Medical Association, Dr. Diehl said, "The results reported by many persons who received placebos would serve as splendid testimonials for anything" recommended for cold prevention.

Another group of students were asked to take cold vaccine by mouth to see if it was any more effective than the injections. Over 350 persons took "cold capsules" containing enormous numbers of dead bacteria. A control series of students were given placebo capsules filled with sugar. The capsules were identical in appearance, and all subjects thought they were receiving the cold prevention vaccine Again there was a remarkable reduction in the frequency of colds as compared with the previous year. The number of colds experienced and the time lost from school was the same whether cold capsules or sugar capsules were taken

Other doctors have confirmed the work done in New York and Minneapolis. After carefully studying the subject for years, Dr. Chester S. Keefer, Professor of Medicine at Boston University and a member of the Council on Pharmacy and Chemistry of the American Medical Association, has concluded that cold vaccines are of no value, his report being read at the Congress of Industrial Health A few doctors still believe that specially prepared vaccines may be helpful for certain conditions, such as recurrent sinusitis.

Vitamin capsules are of no more use than vaccines for cold prevention. Again Dr. Keefer and others have recognized the findings of many researchers in reaching this conclusion.

Dr. Ann Gayler Kuttner has charge of a large group of children in a New York Convalescent Home. In such an institution, epidemics of colds have always been a menace and Dr. Kuttner hoped she could find a way to prevent them. Although the food was well-balanced and nourishing, she thought added vitamins might be helpful. Every day, one half of the children were given a special capsule containing large doses of vitamins A, B, C, and D. The other half of the children were fed and cared for in the same manner, except that they did not get the capsule. Their only source of vitamins was the food they ate. Surely the chil-

dren who took the capsules would have fewer colds, if added vitamins were of value. During two entire winters, there were just as many colds among children who took the capsules as there were among the others.

Cowan, Diehl, and Baker, despairing of the use of cold vaccines, began to experiment with vitamin capsules a couple of years ago. Their conclusions were published in *The Journal of the American Medical Association*. The same careful method of control they perfected when studying vaccines was followed. The vitamin capsules containing large amounts of vitamins A, B, C, and D were exactly like the placebo capsules in appearance. The latter held only a few drops of mineral oil—a substance which could have no conceivable effect in such small quantities

More than 200 students were given two of the vitamin capsules daily and a similar group took the placebos All of them believed they were getting the "cold prevention capsules" There was a 50 percent reduction in colds compared with the previous year whether the students took vitamins or mineral oil. The average number of colds per student was the same in each group Vitamin capsules did not shorten the number of school days lost, decrease the severity of colds, or lessen the incidence of complications. The average duration of colds was 8 2 days among those who took the vitamins as compared with 8 1 days among the students in the control group.

There are certain conditions in which the use of vitamins is necessary, even life-saving; but there is no excuse for indiscriminate vitamin medication because of "lowered resistance to colds" The work of Drs. Kuttner, Diehl, Baker, and Cowan proves that added vitamins do not prevent colds, if the diet is reasonably adequate.

Dr. Diehl has said that the kind of food "these students get is probably not as good as that of the average person who buys vitamin pills" And yet the students were not prevented from getting colds by adding vitamins to their diet. How, then, can the average person, whose diet is better, hope to prevent colds by taking vitamins?

There is no cause for despair in the reports that neither vaccines nor vitamins will keep colds away The recognition of these failures will stimulate research men to study other preventive measures. If the millions spent for vitamins and vaccines could be used to finance continued scientific investigation, a successful method of prevention might be discovered in the very near future.

Meanwhile, sensible living remains the best weapon for preventing colds. Contact with persons who have colds should be avoided, adequate rest must be secured, and a well-balanced, nutritious diet should be eaten.

• • •

CLIMACTERIC

Do Men Also Have Such a Period?

This is a serious question. In an article in *The Journal of the American Medical Association*, Dr. V. Korenchevsky of London, cites a number of medical and biological scientists who suspect that some men do pass through such a period, with symptoms similar to those of castration and appearing at the average age of 48 to 52 years These symptoms are classified as follows:

Nervous and psychic, to which belong intense subjective nervousness, headaches, giddiness, scotomas, emotional instability with an inclination to tears, irritability, sudden changes of mood, decreased interest in the usual activities (even pleasures), a desire to be left alone, decrease or loss of memory and ability for mental concentration, mental fatigability, loss of or disturbed sleep, day sleeping. A typical "climacteric" neurasthenia or involutional psychosis, chiefly in the form of melancholia, with a tendency to suicide which might develop.

Cardiovascular changes: Hot flushes, fits of perspiration, chilly sensations (for example, cold feet), tachycardia, palpitations, numbness, tingling.

General and other changes, including increase of body fat; physical fatigability; rougher and darker skin with wrinkles or folds appearing on the exposed parts; constipation; decreased sex potency and libido.

It usually is ill-advised to publish in a non-medical magazine a list of symptoms; the layman too easily inclines to assimilate his own symptoms to them and diagnose his own ills without realizing that a given symptom, taken alone, may also pertain to a wide variety of conditions other than those described. This is why the advice to ask a physician is the safest always, even though the possibility described above is of interest to men who seem during a period to go to pieces. When a given organism has reproduced itself Nature appears to lose interest in it

HEART WATCHING

Important to Workers in War Industries

Tired hearts which furnish strength to hands manipulating explosives are a source of potential danger to workers in the munitions industry Recently physicians at one of the country's largest explosives manufacturing companies called upon electrical science to help them ferret out cases of heart fatigue among workers in certain departments before the tiredness became so great as to cause fainting

The instrument they are using is called a "sound frequency analyzer," developed by Western Electric Company A great deal more sensitive than the stethoscope, it picks up, analyzes, and records the heart sounds that disclose fatigue conditions that induce fainting.

The plant doctors use the instrument regularly to chart the heart sounds of workers unavoidably subjected to chemical fumes causing heart fatigue. From these charts they are able to tell the degree of heart fatigue suffered by each person. Workers whose charts show heart fatigue are immediately transferred to other departments, to avoid danger to themselves and to other workmen in the plant handling explosives.

WEEKS

Sedentary Workers Feel Vitamin Deprivation within Month

If vitamin B were suddenly withdrawn from the diet, how soon would the effect become apparent? Would it be a matter of years, months, days, hours?

Light is thrown on this question by an article in *American Journal of Physiology* Seven healthy physicians were themselves used as the subjects, and were put on a diet made grossly deficient in the vitamin-B complex Measurable symptoms of the deficiency became manifest within three to four weeks, and consisted of easy fatigue, loss of ambition, and loss of efficiency in daily work The symptoms were mild and vague.

Having acquired a vitamin-B deficiency, after several weeks, does it require the same length of time to recover from it? Generalizations are dangerous but, by and large, the neurological and mental recovery is likely to be rapid; recovery from tissue changes, if any, probably much slower. A general idea of the former is imparted by language used in *Nutrition Reviews* with regard to deficiencies in thiamin (vitamin B_1) in animals used experimentally: "There is a vast amount of evidence," that journal states, "that the administration of thiamin to an animal acutely deficient in thiamin causes a dramatic and prompt remission of the neurologic signs within a period of minutes, and complete recovery within a few hours"

CRYMOTHERAPY

Outstanding Medical Journal Urges its Adoption

Ice anesthesia for shockless surgery of the extremities is brought about by immersing the limb in a pail of ice and water for one or two hours before operation, and was described in Scientific American (April, 1942) by Barclay Moon Newman This method was developed by Frederick M Allen, M.D, of New York Its simplicity and effectiveness were pointed out in our article for the lay reader, and the hope that this method would be used by the military in the field was expressed.

Apparently this form of anesthesia has not been adopted as widely as some medical authorities have hoped, for we find in an editorial in *The Journal of the American Medical Association* urgings which are at once urgings and a strongly implied commendation of the method. *The Journal* states, under the caption "Refrigeration (Crymo) Anesthesia," that "Future generations may find it difficult to understand why it is taking us so many years to appreciate the significance of reduced temperature. The

usefulness of maintaining life processes at a reduced rate by lowering the temperature is still not generally understood.

"Recent reports indicate that in combat areas military surgeons are largely occupied with the care of injuries of the extremities. The older methods of anesthesia for these cases are not completely satisfactory.

"Life processes, in common with chemical reactions, have a speed which is profoundly influenced by temperature. Oxygen consumption of the tissues can be reduced about 13 percent for each degree, Centigrade.

"Refrigeration offers advantages for nearly all cases of severe wounds of the extremities. The large-scale program of medical education for war which is now in progress should include instruction in temperature physiology and advanced courses in the principles and practice of refrigeration anesthesia."

SYPHILIS

What of the Too-famous "One-Day" Cure?

A YEAR or so ago much publicity was accorded to a "one-day" cure for syphilis, and physicians raised their eyebrows. How *The Journal of the American Medical Association* regards such cures may be inferred from the following statement recently published in its columns:

"There is no royal road to the cure of syphilis."

HYPNOTISM

Is It a Fraud? If not, Where Does It Stand?

MANY persons apparently regard hypnotism categorically as a fraud. Perhaps this is because most stage hypnotism—the variety most likely to be witnessed by laymen—is often conducted under auspices that do not inspire confidence. Even then, however, most of it is genuine—probably because it is easier to perform the genuine than to fake an imitation.

But hypnotism is also employed in psychiatric hospitals and elsewhere in the medical world. It is not new and it is not widely used, in a comparative sense, but it remains in good standing in many competent medical circles Just how *The Journal of the American Medical Association* recently answered an insular reader, a doctor of medicine, who inquired about the present status of hypnotism as a therapeutic procedure, and its use by laymen, may be gleaned from the answer which was published in that journal:

"Hypnotism suffered the fate of other methods of therapy which have become associated with charlatanism and which have been hailed with undue enthusiasm. It fell into disrepute with physicians because, unlike psychoanalysis, it deals largely with symptoms rather than causes. It is essentially for this reason that this valuable therapeutic technique may be dangerous in the hands of the public, for symptoms may be created or intensified without a proper knowledge of the underlying pathologic condition All physicians are aware of the power of suggestion, and in the state of hypnosis conscious resistance is reduced to a minimum. The patient is put in a condition of heightened suggestibility and he accepts suggestions without criticism.

"One of the greatest obstacles in psychotherapy is to get the patient to accept therapeutic suggestions consciously. Under hypnosis it is possible to implant therapeutic ideas on the 'subconscious' and to have them take effect when endless numbers of suggestions given in the waking state would be ignored or even actively resisted. Also under hypnosis former dissociated experiences and amnesic material can be rendered available for reassociation and reorganization. Of course, like any form of psychotherapy, the results of hypnosis are individually limited, and they vary in degree and variety with every subject, depending on the innate endowment of the patient.

"Hypnosis has a definite place in psychotherapy. It is not a mysterious art, but a scientific technique."

PLASTICS IN MEDICINE

Many New Uses are Being Developed

BRAIN plates, cups to reline arthritic hips, nylon monofilament sutures that are stronger and less irritating than silk, instruments that "pipe cold light around curves,"—these are some of the hundreds of instruments of surgery and medicine now made from plastics.

Wartime research and experience of physicians and surgeons has greatly intensified the evaluation and adoption of medical applications for plastics, forecasting their increasing use in this field, according to the Plastics Department of E. I. du Pont de Nemours & Company Many instruments are not now generally available because of war demands and priorities on plastic materials

Properties such as toleration by human tissues, exceptional lightness in weight, transparency to X-rays, and virtual unbreakability adapt the plastics for use in delicate brain operations as well as ordinary medicine-chest tongue depressors.

A noted New York surgeon has performed more than 300 skull operations in which a cranial defect was repaired with a plate of "Pyralin" cellulose nitrate plastic. Easily formed to the desired curvature in hot water and sutured in place, the plastic is perfectly tolerated by the tissues, is not absorbed, and becomes firmly implanted in the skull. A similar operation is made in treating certain types of epilepsy

Pain in arthritic hips has been relieved and there has been at least a 50 percent increase in the leg motion—the criteria by which the success of a hip operation is judged—when cups of an acrylic plastic like "Lucite" methyl methacrylate resin have been used.

The material not only is non-reacting to tissue but is transparent to X-rays, which allows the surgeon to see bone structure within the cup. This plastic has also been used for jaw and knuckle joints, as a substitute for metal plates in bone grafting, and in plastic surgery.

Millions of feet of nylon monofilament, formerly used in tennis racquet strings and fishing leaders, will this year replace gut and Japanese silk in sutures for the Army, Navy, civilians, and lend-lease shipments. Nylon does not dry out and rot like the natural fiber.

These plastic sutures are superior to silk. They have greater tensile strength and smaller diameter strands can be used. They are non-absorbing and inert in the body, whereas germs can travel in silk and skin can grow into the twisted threads of a silk suture.

The ability of "Lucite" rods to transmit "cold light" around curves, plus strength and light weight, make them particularly adaptable to the familiar combination flashlight-tongue depressor and a host of other instruments needed to examine the cavities and recesses of the body.

Concentrated, shadowless illumination is given by this plastic in surgical retractors used for lighting up incisions and spreading them apart, as well as in cystoscopes, sigmoidoscopes, proctoscopes, otoscopes, pharyngoscopes, brain and tonsil probes, and speculums.

Shields to protect doctors treating infectious diseases, windows in plaster casts, stethoscope parts, transfusion tubes, incubator covers, and drainage tubes are among the numerous other medical applications for "Lucite," the same plastic from which crystal-clear noses, gun turrets, and other transparent sections of military aircraft are made.

Containers for pills and capsules, vaccination shields, nose guards, artificial fingers, splints, nylon catheters, windows for oxygen tents, respirators and therapeutic boots, dentures—the list of plastic applications in the field of medicine continues to grow.

RAPID GRAYING

Does Hair Ever Turn Gray Over-Night?

THE BELIEF than hair can turn gray over-night is a popular superstitution, according to some, who argue logically from the premise that hair is practically a dead tissue But is this premise itself correct?

On the other extreme are thousands of persons who claim to know of cases in which hair actually did turn gray in a few hours. Not all these cases will, however, bear strict investigation.

In *The Journal of the American Medical Association* the rapid graying question was recently discussed in much more detail than can be done here Though attested cases are rare, *The Journal* accepts some of them, and does not categorically deny all of them. It states, in sum: "The fact that in rare instances hair can quickly become gray must be acknowledged. The old idea that hair is practically a dead tissue, cut off from the metabolic influences of the body, must be forsaken."

'WERS' Calling

Radio Amateurs and Other Volunteer Workers are Setting Up a Communications System for War or Peace

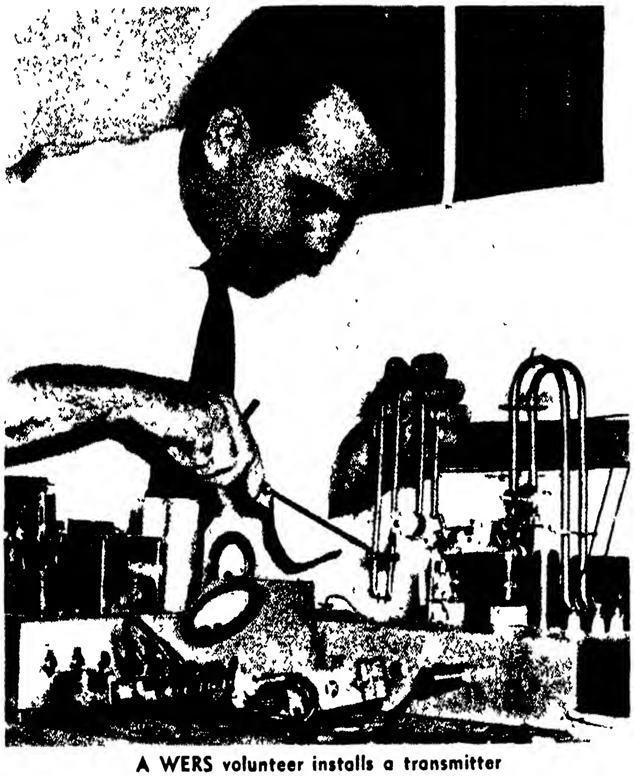
MAJOR GENERAL ULYSSES S. GRANT, III
Protection Branch, U S Office of Civilian Defense

ALONG the coasts of our country and inland where enemy planes may strike, wherever there is threat of disaster from war or the heightened wartime threat of civil disasters—major accident, explosion, conflagration, floods, hurricanes—alert communities are setting up a new, specifically war-planned communications auxiliary, the War Emergency Radio Service Director of the Office of Civilian Defense, James M Landis, says, "OCD strongly recommends that every community faced with the possibility of disasters of this character take steps immediately to give itself this added protection."

The War Emergency Radio Service, WERS, is a system of two-way radio communication, licensed by the Federal Communications Commission, for use of Civilian Defense and other defense forces in local areas It is a characteristically American development and depends on the existence, first, of radio amateurs and other radio technicians familiar with high-frequency transmission, and, second, of a stock of radio equipment and parts unequalled elsewhere in the world.

Wartime necessity led to the banning of amateurs from the air shortly after Pearl Harbor. At that time there were about 55,000 licensed amateurs in the United States. Over 16,000 of these are now in Uncle Sam's service and many thousands more are working in essential war jobs and can give only a limited amount of leisure to WERS work. That puts a particular obligation on those left with full leisure to come forward and to help in setting up the many needed WERS systems. The fact is that few ex-amateurs require urging. On the contrary, they are more than glad to return to radio activities, and through radio to contribute their part to the war.

It must be kept in mind, however, that there are strict limitations on the work they are doing under WERS. For one thing, it is limited to the use of ultra-high frequencies, mainly in the 2½-meter band—112 to 116 megacycles. Then there is the matter of operation. WERS sets are specifically for war objectives. In Civilian Defense (there are also WERS stations for State Guards and Civil Air Patrol) the stations may be operated only during air raids or other emergencies, or during short practice periods once or twice a week The result is that amateurs must go into it with the clear picture in mind that WERS is a limited, licensed system under FCC regulation, that they go into it to do a volunteer patriotic job, and that that job involves putting long hours into station-building, training and other unexciting tasks, and little into actual operation. Yet the operation, when it comes, can count for life and death.



A WERS volunteer installs a transmitter

WERS is just at the beginning of what is expected to be one of the great new developments in the field of defense and warfare. At the time of writing there have been 222 applications for station licenses; 156 have been granted, and about 4500 WERS operators' permits have been issued. There are over 3700 actual operating units, but everywhere in the country the construction of more is on the way and it is expected that ultimately there will be about 100,000 transmitters, 200,000 receivers, and about 300,000 operators to man all this equipment.

This expected large body of personnel will have its recognized place in Civilian Defense. WERS operators will serve in the Communications Unit of the local Defense Corps. This Unit will have the lightning-flash insignia, with a differentiating word for each of the Unit's three subdivisions: WERS, telephony, and messenger service. To qualify for Communications Unit membership and insignia, WERS volunteers will be asked (1) to get an FCC operator's license, (2) to follow a prescribed course of study and (3) to put in approximately 20 hours of in-service training. Many of the personnel who help establish WERS systems will also become operators, but even if all of them became operators, they would fill only a small proportion of the need. The larger number of operators will have to be general volunteers trained especially for the work. Fortunately, this training can be given in an easy six-hour course and does not require previous radio experience.

The part of the job where amateurs and other technically experienced personnel will make the greatest contribution is in setting the system up and putting it in motion.

What is a WERS system? How does it help in the defense work of a community or group of communities? What gives it the dramatic pull and the appeal to the imagination—as well as the good, practical utility—that make it a fast-growing wartime national asset?

The War Emergency Radio Service is a local defense-area system of two-way radio communication that gives an extraordinary flexibility and dependability to essential communications in time of enemy attack or war disaster. The FCC has assigned WERS a number of frequencies, but the main ones, as stated before, are from 112 to 116 megacycles. Within this range OCD recommends that operation be planned for three bands of several channels each. At need there would be available 16 distinct channels so that there is no practical limit to the system's flexibility.

The three bands serve three purposes:

1. One band connects the local Civilian Defense control center with the district control center and so reinforces the community's outside communications.

2. A second band connects the local control center with local fixed points such as wardens' posts, fire houses, hospitals, public utilities, and industrial plants.

3. A third band connects mobile forces like fire trucks and emergency medical teams with the control center. This band can also connect with walkie-talkies, portable sets carried by Civilian Defense volunteers.

WERS transmitters use a maximum of 25 watts input power, which gives an

The radio in this Auxiliary Police car has been converted into a shortwave WERS set, permitting maintenance of constant two-way contact with the control center

effective communicating range of approximately 10 miles, and a maximum practical transmission range of about 25 miles. Operation of sets with this limited range cannot help the enemy. Directional bearing cannot be taken on the stations and it would be useless on such a range to attempt interception of messages.

THERE are three main advantages to WERS:

1. Wide coverage.—WERS can reach many points simultaneously, once its channels are put on the alert. One district warning center can reach all local control centers. The local control center can simultaneously notify all wardens' posts of air-raid signals, for example. The need for telephone chain calling is eliminated.

The system also has value in the case of calls to only one point. All sets are listening in, and operators can break in to give advice or information, or can guide their own forces better through knowing the current situation.

2. Invulnerability.—It is virtually impossible to put the new system out of action. At most a few sets may be destroyed, which can easily be replaced. All other means of communication depend on cables, wires, and exchanges vulnerable to bomb hits and partial or total destruction. A bomb hit anywhere between the two points of communication will usually put all lines out of commission. Radio needs no wire or cable.

3. Contact with moving units.—The new system can reach defense forces in motion. WERS gives all mobile forces a continuous central command and allows them to be shifted from one incident to another without returning to the base Walkie-talkies extend this two-way contact. By means of walkie-talkies, an incident officer or a fire chief or chief of any emergency unit can direct his squads easily and quickly from a vantage point at the scene of disaster.

The new emergency radio system is of direct use to many strategic centers and installations in the community, such as hospitals, industrial plants, railroad yards, docks, bridges, and public utilities. Its importance to these points appears in the two following representative cases:

1. Industrial plants.—Calls to an industrial plant give air-raid warning, advise the plant's Defense Coördinator of latest developments during a raid, confirm calls for emergency units and indicate the help coming, and advise in the operation of the plant's own emergency forces. Calls from an industrial plant summon emergency medical teams, rescue units, fire and police forces, demolition squads, and at need, decontamination units. Large industrial plants can use walkie-talkies to reach plant protection volunteers in outlying sections of the plant or in separate buildings or defense posts.

2. Hospitals.—It is crucial to know during a raid exactly what beds are available and what operating rooms are free in the casualty receiving hospitals of a community, and to direct casualties rapidly to available facilities. If telephones go out, the control center can still keep a complete picture of the hospital situation by WERS. By use of the new system, ambulances can be loaded and dispatched effectively because the control center is in communication both with hospitals and with the incident officers and incident medical officers. Mobile medical teams can be directed from point to point without returning to their bases. If the hospital facilities of an area become overtaxed, the radio channel to the district headquarters can arrange for reinforcing hospital facilities.

Not only in air raids but also in cases of civil disaster will WERS greatly benefit the community's emergency forces. When flood menaces an industrial plant, when fire or hurricane spread damage, and break communications over a wide area, WERS and Civilian Defense units will give the same kind of help to fixed points in the community as described above.

Under the plan recommended by the Office of Civilian Defense, blanket licenses are obtained from the Federal Communications Commission for all the Civilian Defense radio stations within one area of operations. Thus one WERS sysstem covers a district warning area, and the equipment and operators of the entire district are available to any stricken community. This prevents "freezing," for under law, operators in one separately licensed community cannot work in any other unless they bring equipment with them.

LICENSES are issued only to municipal or local governments, such as cities, towns, townships, or counties. They are not issued to police departments, fire departments, or Defense Councils as such. But while licenses are issued to local governments, the WERS system, when set up for Civilian Defense, must be planned under authorization of the local Defense Council and with its guidance. In many cases the initiative comes from the Defense Council, but if not, local radio amateurs and professionals do and should take the initiative themselves. They know the community's possibilities and needs in terms of radio better than anybody else, and are the ones, in any case, to whom the community must turn.

When the Defense Council authorizes the setting up of a system, steps may be taken for obtaining a license The proper application forms can be obtained from the Federal Communications Commission in Washington, D. C. Federal Communications Commission, Rules and Regulations, (Title 47—Telecommunications—Chapter I), Part 15, gives all the necessary information on how to file for a

Civilian Defense radio operators standing-by at West Control Center equipment, Akron, Ohio

WERS License. This can also be obtained from the Federal Communications Commission. A Fact Sheet describing WERS advantages and operation may be requested from the Editorial Section, Office of Civilian Defense, Washington, D. C.

The first WERS system in the country was established in Akron, Ohio. Immediately after Pearl Harbor, Akron's Buckeye Short-Wave Radio Club held meetings and discussed future emergency operations. These discussions, of course, were well in advance of WERS authorization by the FCC, and so this alert group planned in terms of what the FCC might be expected to do. It was the consensus that the FCC would not permit a higher wavelength than 2½ meters, so plans were made on that basis. The Executive Council of the County Civilian Defense Corps was brought in on the plans and appointed the Club president, John A. Bailey, county representative of amateur radio operators. In December, 1941, Bailey presented a report to the communications section of the Council that provided for a two-way system using 16 transmitters of both the portable and fixed types.

Getting Council approval, he went ahead by applying to the FCC for permission to set the system up and—assuming granting of the permission—starting Akron amateurs on the work of construction.

While they worked, the FCC and the Defense Communications Board (now called the Board of War Communications) authorized WERS and allocated it radio channels. As Akron had expected, the main band chosen was 2½ meters (112-116 mc.). Soon Akron received a WERS station license along with operator permits. The station call was WODF, and the first test of equipment was held when the Commander of the County Civilian Defense Corps called a test blackout.

An interesting fact about the Akron system, which is increasingly typical of WERS systems, is that it is designed to tie in with WERS set-ups in nearby communities, such as Barberton, Cuyahoga Falls, Medina, and Hudson

Since that first set-up, important systems have been developed in key sections throughout the country, particularly—as might be expected—along the costal areas and in large industrial communities. Along the Atlantic coast, Massachusetts and New Jersey lead in number of licenses granted, having 19 each (these two states, in fact, lead the country). Pennsylvania has 12, with seven pending. New York has 12, Rhode Island, ten, Connecticut eight. Maryland has six counties licensed with most of the remaining counties on the verge of getting licenses, and with a state WERS network about to go into operation. New York City and Philadelphia have leading WERS systems, New York leading the country and Philadelphia being licensed for 111 transmitters. In WERS systems, receivers equal or exceed the number of transmitters.

On the West Coast, California has nine licenses with its main systems in Oakland, San Francisco, and Los Angeles. Washington has four, with systems in Tacoma, Everett, Olympia, and Spokane. Oregon has two.

Texas has three. Michigan has four: Detroit, Lansing, Grand Rapids, and Center Line.

The story of those actually licensed, however, is not by any means an accurate picture of WERS development, because all over the country other systems are in process of construction, with equipment being assembled and installed and operators trained.

Walkie-Talkie equipment is an integral part of WERS radio equipment

Equipment is one of the main problems, yet there is no question but that our country is in an ideal position to solve any equipment shortage. Automobile radios are adaptable to 2½-meter conversion. Everywhere in the country are thousands of old radios, junked parts, and radio material scrap which in the hands of ingenious WERS constructionists can be reassembled into usable sets. WERS volunteers themselves often donate this material. In addition, some communities put on radio scrap drives for the specific purpose of equipping WERS—attics and the back rooms of radio repair shops are ransacked for old sets and salvagable materials In many cases, factory discards and other material that seems defective or unusable is redeemed through the ingenuity of WERS workers.

The problem of obtaining personnel for setting up WERS systems is a very real one, and is taking on increasing importance. Great as the contribution of amateurs has been, many communities do not have enough amateurs to do the job. In such communities, radio repairmen and broadcast station engineers and operators have stepped in, and in their leisure hours have given extremely important help, help that should be mentioned along with that of the amateurs. Broadcast station personnel, for example, have been able to borrow precision test equipment from their stations with which they check WERS equipment to see that it fulfills FCC requirements. If the equipment needs adjustment, they make the adjustment required. They also are in a position to give invaluable constructional help and advice. In many instances, broadcast engineers and operators have been appointed Radio Aides and have organized and directed WERS work.

Radio service men have been making an equally important contribution. They have been particularly generous in donating usable or salvagable materials for WERS—in many cases they have built full units for WERS in their own shops, and have opened their shops to other volunteer construction workers, giving them an ideal place in which to work. When the sets have been built, the radio service men have volunteered on a wide scale for the equally necessary work of installation and maintenance.

Mention should be made, finally, of the help given by High Schools, Technical and Vocational Schools, and colleges which in many parts of the country are offering their shops as work places for WERS.

WERS is on its way. Although it is still only at the stage of initiation, it is developing rapidly a body of enthusiastic workers and a fund of invaluable experience derived from the ingenuity, resourcefulness, and devotion of the amateur and professional radio personnel of the country. The impetus to setting up WERS comes both from the Civilian Defense organization and from these patriotic and informed radio people who see in WERS the great communications auxiliary it is, a channel of warning and co-ordination within the community and of emergency appeal outside in time of disaster No bomb can destroy more than a small fraction of WERS equipment, and any key point can be rapidly re-equipped The system is always there, it goes on effectively serving under all conditions. As WERS develops, America will be better prepared for all emergencies, whether of war origin or the recurring and now intensified castastrophes of civilian life. When full preparations are made, damage to life and property is minimized, and even, to a degree, the threat of enemy attack is lessened, for the enemy is not tempted to attack well defended areas.

• • •

ELECTRIC "BRAIN"

"Remembers" What Happens in a Rectifying Circuit

A paper and aluminum "brain" that memorizes surges of electric current and records them for the benefit of research engineers is making possible better electronic tools for war production. Little bigger than a loaf of bread, the "memory machine" was built by William E. Pakala, a research engineer at the Westinghouse Electric and Manufacturing Company. It was designed to help scientists study the Ignitron, an electronic device that converts alternating current into the direct current required by alu-

minum and magnesium plants. Teamed with an oscillograph, which jots down on photographic film a record of the electricity passing through a switch, motor, or electronic tube, the "brain" tells engineers exactly what happens inside the Ignitron.

The Ignitron converts alternating electric current to direct current that flows

Adjusting a battery of "brains"

in one direction only—just as a valve in a water line lets the water flow in only one direction, the engineer explains. When water begins to flow backward, the valve closes. And so an Ignitron refuses to let the electric current move backward.

But infrequently an Ignitron will "arc-back," like a valve that fails to close when the water flows backward, Mr Pakala says. There is no way to forecast when this undesirable "arc-back" will occur.

Previously, engineers studied such electrical phenomena with the oscillograph. "But the oscillograph alone was unsatisfactory," Mr. Pakala says, "because we never knew when the arc-back was coming and we couldn't expose hundreds or perhaps thousands of feet of film while waiting for it. From a standstill the oscillograph could not go into action fast enough to get a picture of the arc-back, which lasts only 1/60 of a second.

"Then I had the idea—why not put a machine between the Ignitron and the oscillograph that would remember what happened inside the Ignitron? This would give the oscillograph a chance to begin operating and then the memory machine would recite the message so it could be picked up and photographed."

To do this, Mr. Pakala converted an ordinary electric motor, not much bigger than the one on a washing machine. He stripped the copper wires from the revolving part of the motor and replaced them with layers of aluminum foil and paper. These electric "reservoirs" can store an electric charge, then release it when they are tapped.

Each capacitor was connected to one of the copper bars on the motor's commutator and the whole memory machine was hitched to a real electric motor that made the brain whirl at a steady speed.

"A graphite brush rubbing against the memory machine's revolving commutator takes electric current from the Ignitron and feeds it into each little reservoir as the memory machine spins around 1800 times a minute," Mr. Pakala explained.

"If the current shoots up for an instant, the reservoirs that pass the brush during that time receive a greater charge than the other capacitors on the whirling rim.

"When the reservoir completes one revolution it is discharged by another brush rubbing against the commutator. This brush drains off each charge and leads it through a wire to the oscillograph which has already been set in motion by an electronic switch closed by the arc-back."

When it is turning 1800 times a minute, the brain "remembers" things for one-thirtieth of a second, long enough for the engineers to get an oscillograph picture of what happened just before, during, and after the arc-back.

As the brain turns faster, its memory becomes shorter. But then it remembers more details of the surges or high voltages in the different parts of the Ignitron tube If it turns more slowly, its memory is longer but it tells the oscillograph —and the engineers—fewer details.

RADIO SEWING MACHINE

Radio Current Replaces Needle and Thread

A radio sewing machine recently developed has promise of becoming one of the new radio-electronic machines of the post-war period, when expansion of its use may be extended through wartime developments.

Instead of needle and thread, this machine uses radio-frequency current; instead of woven cloth, it works on thermoplastics—the new synthetic materials that are finding wide application in the making of raincoats and caps, weather balloons, and in the packaging of many types of food and oils.

It "stitches" a thin, solid seam that is air and water tight, creating a bond that is stronger than the material itself. It does this simply and easily, thus promising to overcome many fabrication difficulties involved in conventional processing methods as applied to thermoplastics.

The radio sewing machine was created by RCA Laboratories to meet a definite need in the plastics industry. Thermoplastics, tough resilient materials, can be rolled into large cloth-like sheets, which makes them highly useful in any number of ways. When cut into patterns, the sections are usually put together by sewing with thread, by cementing, or by fusing with externally applied heat None of these methods has been found to be entirely satisfactory for mass production, although fusing by heat appears to be the most desirable method. But there are problems of maintaining uniform temperature and of processing equipment becoming gummy and sticky.

By generating heat inside the material itself, RCA's radio sewing machine eliminates these difficulties. This is what happens. The material to be sealed, or "sewed," is fed across a table top through two small roller wheels which serve as the "needle." The wheels have two functions: To pull the material along and to act as plates which set up a small electromagnetic field of radio-frequency current As this current passes through the material, heat is generated by dielectric loss, or, in other words, by the struggle of the current to get through the closely packed molecules of matter which compose the material. The heat causes thermoplastics to fuse, or weld, in a tight bond.

Somewhat similar in appearance and operation to the conventional sewing machine, the radio device derives its

A thin, solid seam is "stitched" in plastic by the radio sewing machine

current from a low-power radio-electronic oscillator. A small electric motor drives the roller wheels Controls are in a foot pedal. Ordinary alternating current of 110 volts supplies the power.

Laboratory tests, according to RCA, have revealed that the radio machine is an effective instrument for the handling of such thermoplastics as vinylite, koroseal, and pliofilm. All three of these materials are being used in a widening field of practical applications.

COFFEE SHIPMENT

Expedited by Opening of New Bridge

The new railroad bridge over the Suchiate River between Mexico and Guatemala has opened a land route for the shipment of coffee to the United States from Central America.,

In the first two months of the operation of the new bridge, according to figures from the Mexican Government Railway System, more than 60,000 bags of coffee (154 pounds each) originating in Guatemala and destined for the United States were handled by the overland route.

This is only a small fraction of the enormous consumption in the United

States, but shipping of coffee over the Mexican railways illustrates how the Americas are seeking to solve the wartime shipping shortage which has curtailed imports of coffee from Brazil and other distant sources which are without rail connections with the United States.

To facilitate overland traffic from Central America to the United States via the Mexican railways, the Suchiate Bridge was rushed to completion last year as wartime shipping shortages restricted inter-American trade. Mexican railways today are being called upon to handle an increasing flow of minerals and other strategic materials from Mexico into the United States. This movement is expected to increase sharply this year and thus may crowd out extensive shipment of coffee and other non-war commodities from Central America.

The new bridge makes overland transit between Mexico City and Guatemala practicable in 48 hours. Prior to construction of the bridge, railway freight had to be unloaded on the banks of the border river and ferried across

The Suchiate Bridge is counted on as a substantial aid to facilitate movement of supplies into Guatemala, El Salvador, and other Central American countries, while proving a boon to northward movement of their commodities to United States markets.

WAR LIGHTING TOOLS

Will Find Numerous

Peace-Time Applications

LIGHTING techniques now being developed essentially for military needs are due to play an important part in post-war reconstruction and peacetime living, according to Samuel G. Hibben, lighting authority. He says that most of the lamps for tomorrow's lighting jobs "are ready to graduate from the research laboratories and battlefronts onto the retail counters

"If we are to achieve our national destiny as the center of cultural living as well as of democracy," he declares, "we should begin by using all of the amazing lighting tools that science is now placing at our disposal."

Pointing out that those who have experienced blackouts and dimouts have had the discomforts and dangers of darkness strongly impressed upon their minds, Mr. Hibben says that for the first time in their lives, perhaps, they have become "light conscious." "When the war is over," he continues, "there will undoubtedly be a decided reaction from these conditions as evidenced by a much greater use of good lighting and new lighting methods, first as an expression of freedom and cheerfulness and later as a means to greater health, safety, and efficiency.

"We now have a civilian army of some 20,000,000 factory soldiers, more than half of whom are dependent upon artificial lighting during the major part of their working hours.

"The millions of fluorescent lamps now producing artificial daylight in the nation's war plants have demonstrated so thoroughly to war workers the benefits of comfortable vision that I doubt very much if they will be content to live in ill-lighted homes when the war is over"

As an example of the part to be played by lamps in guarding the nation's health, Mr. Hibben cites one product of Westinghouse research laboratories—an ultraviolet lamp which destroys germs and prevents cross-infection. "This Sterilamp," he says, "is on its way to becoming a regular part of the air-purifying systems in schools and public places where it can reduce infectious diseases Before long it may be commonly employed in our homes."

Among the other peacetime applications of lighting developments, Mr. Hibben forecasts "controlled weather conditions," explaining:

"The compact lamp that radiates infrared or radiant heat now is being used to dry the painted surface of a military tank in three minutes and to do a similar job on plastic helmet liners for the Army. After the war this same lamp may provide 'good weather' by casting its artificial beams on our plants and vegetable gardens. As a substitute for the sun in this capacity it could do a creditable job.

"Experience gained during the blackouts and dimouts will result in vastly improved street lighting. Uncomfortable glare will become a thing of the past

since it is possible to have good lighting without it.

"Interest in new achievements should also bring into wide use the invisible ultra-violet rays known as 'black light.' Today this light enables aviators and submarine crews to see the fluorescent instrument dials which glow when struck by ultra-violet. Tomorrow, home wall decorations painted in luminescent colors, will glow brilliantly when activated by this same 'black light.'"

ALL ANCIENT

Bamboo Books, Paper, and Pencils in Ancient China

BOOKS with bamboo pages resembling a hammock of wooden slats, were widely used in ancient China 14 centuries before Christ, according to Dr. Arthur W. Hummel, curator of Orientalia at the Library of Congress, Washington, D. C.

These early books apparently were similar to later books written on narrow strips of bamboo wood, some almost two feet in length. These strips were laid side by side and bound together by cords at the top and bottom. The writing probably was done in ink with small hand brushes.

The narrow wooden strips suggest vertical rather than horizontal writing and this probably explains why the Chinese have always written in vertical columns.

Paper was invented about 100 A.D. by Ts'ai Lun.

The lead pencil was used for making notes in classrooms as early as the 2nd Century, A.D., and probably was invented earlier.

"BIG-INCH" WELDING

Speeds Construction of Largest Oil Line

WELDING operations used in constructing the "Big Inch," largest oil line ever built, are speeding up construction through all kinds of terrain.

The line, which has a capacity of 300,000 barrels of oil per day and is made of 24-inch seamless pipe of 3/8-inch wall thickness, runs from Longview, Texas, to Norris City, Illinois, and is being extended to the Atlantic seaboard.

After a section of pipe has been brought up to the end of the line, and pulled into position by tractors, men of the tie-in crew stand on the pipe to bring the ends into alignment. Then the tacking crews of the firing-line gang go to work. The pipes, mounted on dollies, are lined up, clamped, and tack welded ready for the roll welders, who complete the job of the tackers and join lengths of pipe into one section. First

Along the "Big Inch." *Upper left:* Men of the tie-in crew stand on pipe to bring the ends into line. *Above:* Lining up and clamping a section of pipe to the end of the line. *Below:* Putting the last pass of a roll weld on one section of the "Big Inch"

Illustrations courtesy Lincoln Electric Company

pass is made with 3/16-inch "Fleetweld 5" electrodes at 200 amperes. Second pass is made with 1/4-inch electrodes with 325 amperes. Third pass is made with 5/16-inch rods with 375 to 400 amperes. When completed, the weld is "penny wide" and "nickel high." Each roll welder marks his weld with a stencil. Careful inspection discloses any pin holes and these are rewelded by the roll welder before he leaves that section of pipe.

OIL ROCKS

Now Classified to Aid the Hunt for Petroleum

THROUGH finding the essential microscopic characteristics of various types of rocks, Dr. Paul D. Krynine, assistant professor of petrology and sedimentation at the Pennsylvania State College, has been able to formulate a classification of sedimentary rocks, based on their evolution, which it is believed may be of value in discovering new oil fields. Where a particular rock or sand fits into the classification indicates where and what type of oil may probably be found.

This is the first systematic petrographic classification of sedimentary rocks ever made, though igneous rocks have long been classified.

The characteristic composition and texture of the rock is intimately related to the movement of the earth's crust many million years ago, Dr. Krynine believes. The texture or appearance as well as the chemical and mineral composition of different sand types indicate the geologic changes they have been through in the earth's evolution.

Oil in California comes from sand or rock reservoirs produced during mountain-making motions of the earth. Through the microscope the pattern of these rocks looks different from the oil bearing sands of the eastern United States and most of the Gulf coast, which have been formed during milder motions of the earth. When the earth is relatively quiet, a third type of rock is formed which becomes the reservoir from which the oil of most of the mid-continent and east Texas is derived.

Since most of the so-called "anticline" fields in the United States have now been discovered, the future of oil production rests on finding new fields, or on stepping up the production of the fields now in use. It is believed that Dr. Krynine's classification may be an important factor in the discovery of new fields. With the scientist's blueprint to guide him, the engineer can drill with greater assurance of finding oil.

• • •

CURVATURE—The actual curvature of the earth for any distance can be worked out simply by multiplying the square of the distance in miles by .67 and the answer—in feet—tells how far the earth has "curved under" at that point. Ten miles from the point where an observer is standing, for example, the surface of the earth is actually 67 feet "lower" than the observer.

• • •

FLEXIBLE TUBING

Made of Plastic as Rubber Replacement

PLASTIC tubing with all the flexibility of rubber and adapted especially for use in breweries and creameries is now being produced from materials far lower on the critical list than rubber, thus making it available for a wide range of purposes for which manufacture of rubber tubing is prohibited under present conditions.

Exhaustive tests which Goodyear Tire and Rubber Company made of its new plastic tubing before announcing its availability disclosed that it has practically the same resistance as rubber tubing to extremes of temperature.

In addition, it is stated that the new plastic tubing will resist pressures up to 40 pounds per inch when unbraided—approximately the same strength as rub-

ber tubing—and up to more than 200 pounds per square inch when braided.

Unbraided, Goodyear's new plastic tubing is transparent to disclose immediately any obstructions which might occur. It also can be produced in an opaque finish or in colors. Tests likewise have shown that the new plastic tubing in some applications is less prone to pick up odors than rubber tubing.

POWDER METALLURGY

Round-Up of Important Industrial Factors

THE SUBCOMMITTEE on Powder Metallurgy of the American Society for Metals defines powder metallurgy as follows: "Powder Metallurgy is the art of producing metal powders and shaped objects from individual, mixed, or alloyed metal powders, with or without the inclusion of non-metallic constituents, by pressing or forming objects which are simultaneously or subsequently heated to produce a coalesced, sintered, alloyed, brazed, or welded mass, characterized by the absence of fusion, or the fusion of a minor component only."

While the art of using metal powders goes back hundreds of years B.C., powder metallurgy as we now know it obtained a large-scale commercial application as soon as tungsten became the useful metal for electric lamps.

The melting point of tungsten is so high that it is uneconomical, if not impossible (due to the absence of suitable refractories), to melt and refine the metal by orthodox methods; hence tungsten was prepared by the reduction of the finely divided tungstic oxides in the solid state. This reduction left tungsten as a powder which was compressed originally by the use of binders (later without binders), sintered, and subsequently after going through various steps of preparation, drawn to the fine wire now familiar to all.

The same procedure of reducing the oxides to metal in the solid state, particularly with a gaseous reducing agent, has been adopted for a large portion of the metal powders now used; but electrolysis and atomization are other methods also used. Iron and copper powders are produced by reduction of the oxide by the use of hydrogen, coal, gas, or by electrolysis. The light metal powders, such as aluminum powders, are produced by atomizing; so also, generally, are lead and tin.

In preparing either the straight metal powder or the alloy powders, the features which should be most carefully watched are purity of the metals and the shape of the metal particles. Only clean surfaces of the metal particles will give a continuous cohesive surface in compression, thus assuring subsequent strength in the finished part.

The shape of the particles of metal powder should be angular, not globular, as globular powders do not compress well, though for certain applications, such as filters, globular powders may be used advantageously. Globular powders compact without pressure and, therefore, do not lend themselves well for parts which have intricate configurations. Angular particles will deform under pressure, interlock, and give strength of cohesion to the compact sufficient to permit handling of the compacted piece even before sintering. Where clean surfaces of the powder particles are assured, the heat created by pressure and friction is sufficient to create a molecular weld.

Metal powders are available of practically all known metals, but in addition a number of pre-alloyed powders such as brass powder, bronze powder, and ferroalloy powders, have been produced. In the case of some of the age-hardening alloys, however, it has been determined that these alloys are best created during the process of sintering. The age-hardened powders are generally too hard to compact easily, and even when they do compact, the resulting part is generally brittle and of low physical properties; whereas if the compact is formed from the copper, aluminum, magnesium or in the case of ferrous metals, iron, nickel, or chrome, the metals can be annealed before compression and the softness of the powders allows excellent compression conditions. The alloys are then formed during the sintering operation.

The next step of importance is the mixing of the powders, their compression in dies, and subsequent sintering. Since compounds of from two to six different metals are frequently required, it is important not to mix light and heavy metals as they will tend to segregate and will not compact into a homogenous mixture. Even if the mixing or blending of the different metals takes place immediately prior to their use, the mixing must continue from a few hours to 24 hours or longer—depending upon the nature of the mixture—to insure an absolutely even distribution of the various particles.

Pressures to form a compact vary from a few tons to a hundred tons per square inch and of late Dr. Clarence W.

The Garand rifle sighting equipment, with sight projectors raised

Balke of Fansteel Metallurgical Corporation has increased his pressure to 160 tons per square inch to obtain high physical properties in iron parts recently prepared. The selection of the desired pressure is governed entirely by the physicals expected in the finished part, how close such part is to come to the full density of the metal, or alloy made by orthodox methods, or how much porosity is expected.

The advantages of powder metallurgy lie in the fact that production can be assured at a very rapid pace, and to very close tolerances, eliminating practically all need for machining and subsequent loss of raw material.

• • •

LAMINATED—To preserve and protect the huge laminated arches and beams used in airplane hangars, recreation centers, and so on, some manufacturers are now dipping them in tanks containing synthetic resin preservative and sealer before erecting them on the job.

• • •

GLASS TANKS

Now Made of Heat- and Chemical-Resistant Sheets

GLASS TANKS for industrial or commercial applications requiring a non-corrosive, shock-resisting material, and using a minimum of critical material have been developed by the Pittsburgh Plate Glass Company. They are not just glass lined, but are actually tanks made of glass, made by building up the required shape and size of heavy tempered glass plates. The result is a rigid, permanent, sturdy tank, free from maintenance or wear.

Mills, factories, plants have heretofore experienced difficulty in holding acids or chemicals in tanks that would at the same time be free from attack. The new glass tanks eliminate practically all the former difficulties.

The new method of heat treating gives to the tank material a physical strength four to five times greater than ordinary glass. Furthermore, the glass has a high resistance to thermal shock. It will withstand continuous operating temperatures of 650 degrees, Fahrenheit, and an instantaneous thermal shock of 400 to 500 degrees.

The joining problem is comparatively simple since the glass is made in large sheets; on all tanks of medium size nothing but the corners are involved. All joints are accurately ground so that they resemble, in a sense, the ground stopper of a chemist's bottle. In addition, use is made of a joining material developed especially for this purpose. The entire tank is usually surrounded by a wooden frame work filled with a compound. This frame serves both as insurance against leaks and as protection against severe physical blows.

Tanks of glass have already proved their ability to take it and continue to give service in one of the most severe of all tank applications—pickling tanks for steel and other metals. Their successful initiation here has caused a demand for them in other industries, such as the rubber, synthetic rubber, chemical, textile, paper, photographic, electroplating, and many other fields.

RIFLE SIGHTING

Done With Mirrors, Saves Time and Ammunition

PRECISION sighting of Garand semi-automatic rifles in quantity production for the United States Armed Forces can now be done with mirrors and without firing a shot, through the use of new equipment developed by the General Electric Company.

Officially known as an "Optical Rifle Sighting Gage," the equipment will save up to 13 rounds of ammunition formerly used in sighting each gun, and will permit a girl to do the job in less than two minutes per rifle—about half the time it took two men by the old method. Moreover, the optical equipment requires less room than the average domestic kitchen, whereas sighting by firing requires a 100-yard rifle range.

When sighted by the optical gage, all the rifle "fires" is a light ray at a mirrored taget approximately six feet in front of it. The ray is caught by another mirror on the gage equipment at the operator's eye level and is thrown onto a ground-glass screen in the image of a cross. Superimposing this image upon another cross on the ground glass correctly positions the rifle, and the gun is then sighted by adjusting its rear sight so that its shadow, magnified 25 times on the screen of a projector directly above it, is in the same relative position as the shadow of the front sight, similarly magnified on another projector above it.

Although the optical sighting gage was built specially for the Garand rifle, it can be adapted to sight other types of rifles.

What the gage actually does is to transfer the sight setting from a "master" rifle, correctly sighted by firing, to rifles subsequently sighted in the equipment.

Inserting the Garand bore plug

The gage is set for accurate use by placing the master rifle in it, and adjusting the equipment to conform to the bore direction and sight positions of the master rifle. When other rifles placed in the gage are aligned with the target optical system, and their sights moved to the proper position as designated by the sight projectors, they are given the line-of-sight to line-of-bore relationship established by the master rifle.

The target optical system consists of a light source and condensing lens, a cross-shaped aperture, a concave mirror mounted on the end of a four-inch bore plug, an adjustable mirror mounted above the light source, and a mirror and ground

glass screen on the main fixture. The light bulb, lens, aperture, and adjustable mirror are contained in the separate target unit which is mounted approximately six feet in front of the main fixture and facing it.

The concave mirror is mounted on a bore plug. The plug is inserted in the muzzle of the rifle for each sighting, its mirror facing the separate target unit.

Light leaves the bulb in the target unit, passes through the lens and the aperture, and is focused on the concave mirror on the plug in the shape of the bulb filament. It reflects to the adjustable mirror mounted above the bulb in the target unit, and then back to the mirror on the main fixture which throws the cross image on the viewing screen. Focal length of the concave mirror on the plug is such that it focuses the image of the cross aperture on the screen

The two sight projectors are optical systems designed to magnify the images of the sights approximately 25 times and focus them on viewing screens. They are mounted on separate arms so that they may be lifted to permit inserting and removing the rifle The two arms rotate about a common shaft, and are raised by a handle attached to the shaft The arms and projectors are held in the up position by an automatic latch. Each projector has a dash pot which prevents it from being jarred when dropped into position, and individual stops to limit the downward position.

• • •

EXPLOSIVE—Cyclonite, a new explosive for bombs and shells, explodes even faster than TNT.

• • •

FATTY ACIDS
Hold Promise for New Industrial Synthetics

A NEW family of synthetics using fats as a basis is predicted by Dr. A. W Ralston in "Chemical and Engineering News," the available supply of these fats in vegetable, animal, and marine life being essentially unlimited.

"A study of the structures of various fatty acids combined with a realization of their ready availability shows that they present an exceptional opportunity for synthetic work," Dr. Ralston says Fats are one of the greatest sources of compounds for chemical synthesis known to mankind. It is now clearly apparent that many of the compounds which can be synthesized from fatty acids are destined to become important chemicals in the future.

Fats are comparatively simple compounds, which are structurally similar and which can be easily separated into their major components—glycerol and fatty acids. Many of the fatty acids can now either be separted from one another or can be segregated into groups of acids which possess similar chemical properties

"The glycerol part amounts to about 5 percent of the weight of most fats so that the fatty acids comprise by far the greater portion of the fatty molecule," Dr. Ralston continues. "Glycerol is a compound for which many uses have been found, both in peace and in war. The problem of chemicals from fats, therefore, is centered about the major component, the fatty acids. . . .

"Recently, quite a number of fatty acid derivatives have been developed, some of which are now available commercially They can be roughly divided into two classes. The first comprises the simple derivatives in which the hydrocarbon group retains its identity, and the second, those in which this group is a part of a very complex molecule.

"Examples of the simple derivatives are the alcohols, aldehydes, acid chlorides, ketones, esters, amides, nitriles, amines, and the many compounds which can be prepared from them. The complex derivatives are represented by plastics, polymers, elastomers, and similar substances.

"Amides are formed by the removal of one molecule of water from an ammonium soap They are relatively high-melting solids which are useful as waterproofing agents, protective coatings, and chemical intermediates. The amines and their salts

have an ever-increasing number of industrial applications. They have been found to be useful in many fields such as flotation, water treatment, and textile finishing. They are strongly adsorbed upon glass, pigments, silicates, clays, limes and metals and decidedly modify the surface properties of such substances.

"The amines possess bactericidal properties and certain of them act as insecticides. They are the starting point for many types of derivatives of commercial interest. We can easily visualize that the nitrogen derivatives of the fatty acids present a field for investigation which can well occupy the attention of chemists for many years to come."

SILVER BEARINGS

Plating Speeded Up by Potassium Cyanide

In the production of silver-plated bearings for airplane motors, the rate of plating is more than trebled by use of potassium cyanide, formerly imported from Europe but now made in this country by the Electrochemicals Department of E. I. du Pont de Nemours & Company.

Literally tons of silver are used each week in the fabrication of bearings which will withstand the high loads and terrific speeds demanded in modern wartime operations. According to some authorities, air speeds would be reduced as much as 75 miles an hour and loads would be cut substantially if silver-plated bearings were not available.

Potassium salts now are recovered by re-crystallization from vast salt deposits in desert areas of California These salts provide the basic material from which potassium cyanide is manufactured. In an electroplating bath, potassium cyanide not only increases the rate at which silver plate is deposited on the motor bearings, but also gives required heavier coatings that are smooth, firmly adherent, fine grained, and easily machined or burnished. Coatings of silver deposited on the bearings, some of which are three to four inches in diameter, range from three to five one-hundredths of an inch in thickness, whereas silver electro-deposits usually are measured in thousandths of an inch.

• • •

SHAMPOO—*First-aid kits on many American ships now include a supply of a liquid soapless shampoo. Experiments have shown that the shampoo is of value in removing fuel oil and similar substances from sailors rescued at sea.*

• • •

SILVER BUS BARS

Conduct Electricity in New Magnesium Plant

Electric current flowing through huge bus bars of solid silver recently brought another great magnesium plant into production, when Dow Magnesium Corporation poured its first metal in the fifth Dow-process plant built by The Austin

Starter cables to the silver bars

Company for the Defense Plant Corporation, to meet the wartime demand for this lightest of all structural metals

The silver almost completely replaces copper in the power distribution lines required for large-scale production of magnesium, and was loaned by the government for this use to release copper for shells, ordnance equipment, and other war needs. The silver is even more efficient as a conductor of electricity but would not normally be used because of its excessive cost.

• • •

PESTS—Millions of two-ounce cans of body dusting powder for the U. S. Army protect overseas personnel against typhus-carrying pests.

• • •

EMERGENCY LIGHT

Turns on Automatically

When Power Fails

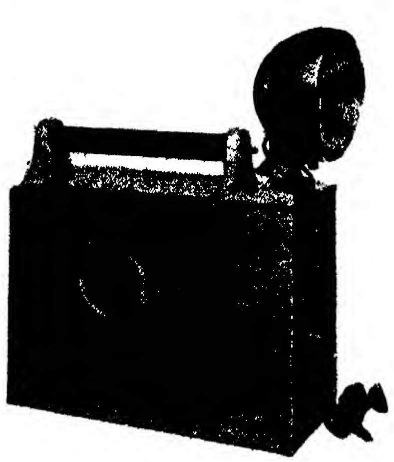
REQUIRING no fixtures or wiring other than plug-in connections to the A C. supply, a new emergency lighting unit has been designed to meet the need for a source of emergency light in war plants, arsenals, ordnance plants, shipyards, factories, and other places where war-time activity has increased the potential dangers resulting from power-line failure, fires, and sabotage. It throws a beam of light 50 feet wide a distance of 150 to 200 feet, covering an area of 7500 square feet.

With power lines loaded to capacity, plant feeders are in many cases overloaded, needing only a slight upsetting load condition to produce a lighting failure. When the lights go out and machinery continues to run on momentum, the Exide Lightguard, by automatically switching on a broad beam of light, helps to reduce the accident hazard, particularly in those plants where men and women unfamiliar with machinery are working. It is especially useful in windowless plants, many of which have been built recently.

The Exide Lightguard has been designed for use where workers are em-

ployed at night on machines, particularly in crowded spaces; for emergency lighting at control equipment, electrical or mechanical, such as power switchboards, telephone switchboards, pumps and valves; in boiler and engine rooms for reading gages and operating valves; in plant gate houses, entrance and exit locations, first-aid stations, and dispensaries.

Because it is a self-contained unit weighing only 47 pounds, this new light



For use when power fails

can easily be moved from its customary position during a fire, accident, explosion or air-raid, for use in rescue work.

The new unit operates instantly and automatically without a hand touching a switch. The only maintenance required is the occasional adding of water to the storage cells. Recharging is done automatically by trickle charge, state of charge being clearly indicated by pilot balls

ENGINEERING WILL WIN
By Making Best Use of Skill and Materials

BECAUSE of the importance of making the fullest possible use of available resources, the side with the best engineering will win the war, according to L. A Umansky, Assistant Manager of General Electric's Industrial Engineering Department.

"The real meaning of the word 'engineering' is making the most skilful and efficient use of the available materials and of human effort," Mr. Umansky says. "The foremost job of engineers is, therefore, to conserve our critical materials, which can be done in the following three ways: By use of alternate materials more readily available; by working available materials harder; and by using available materials more skilfully. All three methods or a combination of them is being actually used by engineers in furthering the war effort

"For instance, since the aircraft industry has first call on all aluminum production, other industries had to use steel, zinc, and other materials and had to modify their designs so as to make the use of these materials possible without impairing the performance of their equipment One electrical manufacturer alone is saving in this manner up to 8,000,000 pounds of aluminum per year"

Many other substitutions of this kind have been made but no good substitute has been yet found for copper as a current-carrying material, he pointed out. True enough, on some large electro-chemical installations, silver busbars have been employed, the silver being withdrawn from the government vaults and put to work. Such an application, spectacular as it is, cannot be used universally since the amount of silver available in the world is a small percentage of the copper requirements. The electrical industry and other industries manufacturing combat equipment have their just claim for copper, he added. Any ton of copper saved by skilful engineering does not mean merely that a few hundred dollars are saved but that this copper can be used to manufacture some 80,000 machine gun cartridge cases. Even if only one percent of these rounds of ammunition reach their goal, there will be 800 fewer enemies facing us, and the end of the war will be that much nearer.

"Electric equipment can and should be worked harder during the war just as the men and women in the services are doing and as the men and women on the homefront are expected to do," Mr. Umansky declares. "Overloading a motor may shorten its life from 20 years to 10 but this span will cover the expected duration of the war. Of course, this method is not always applicable to an older machine, since the aged insulation may fail and the failure may cripple industrial production."

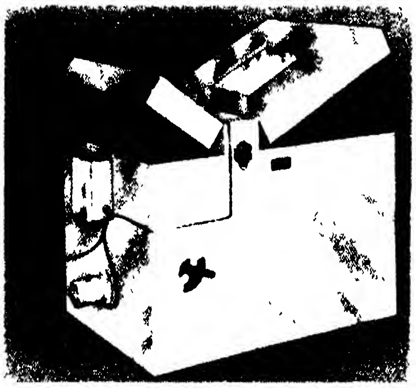
As an example of skilful engineering, intended to conserve our natural resources, Mr Umansky cited the method of connecting airplane engines under test to a generator and pumping energy which would otherwise be wasted back into the power system. At several engine factories, up to 60 percent of the energy required to operate the entire plant is thus obtained and if all airplane engines were tested in this way, approximately 750,000 tons less coal would have to be mined and transported annually, he added.

"No effort should be wasted on anything that will not help to win this war," he says. "However, this does not mean that engineering developments and investigations should be stopped during the war. On the contrary, they should be stimulated, since this war, more than any other in history, is a war of machines, of engineering. With the nation at war, the engineering profession must do double duty in blazing new trails, in trying new ideas, in venturing into the unknown. Co-operative effort is needed as never before"

DRY-ICE CABINET
Holds Temperature Within Close Limits

WHEREVER reliable, convenient, trouble-free, and speedy refrigeration is required in the laboratory, a new cabinet developed by the American Instrument Company will be found useful. It provides temperatures from minus 90 degrees, Fahrenheit, up to 220 degrees, Fahrenheit, with a

constancy of plus or minus ½ degree and is intended for use where expensive mechanical refrigeration would not be justified. Two temperature ranges are available: From zero to minus 90 degrees



Dry-ice cools the cabinet

and from 220 degrees to minus 90 degrees.

Temperatures can be held at minus 40 degrees and minus 90 degrees in an ambient temperature of 85 degrees for 24 hours with 40 and 60 pounds of dry-ice respectively.

The cabinet is portable and ready for operation after packing with dry-ice and plugging the cord into the current supply. Once packed with dry-ice it requires no further attention until a new charge of dry-ice is required.

In the low-temperature model, close temperature control is made possible by means of a thermo-regulator, which, through a solenoid and an electronic relay (time-delay), operates a damper that allows air to be passed over the dry-ice when cooling is needed, or to be bypassed when cooling is not needed. The temperature control system requires only natural heat leakage for its operation. No electric heaters are used in this model to control the temperature.

In the high-and-low-temperature model, the control described above is augmented by electric heaters operated through a relay.

The working chamber (24 by 24 by 24 inches) has a hinged removable cover in which is incorporated a five-ply vacuum-sealed plate glass window. Another hinged cover is provided for access to the dry-ice compartment. Air is circulated constantly through the cabinet by means of a fan located beneath the dry-ice compartment, the fan being driven by a motor mounted outside the cabinet.

MINE GAS
Reduced By Drawing Off Through Pipes

DEFINITE economy in ventilation costs, by freeing coal mines of dangerous gas before a seam is worked, is being accomplished by sinking pipes into the ground ahead of the workings and pumping the gas out, according to the Compressed Air Institute.

This is being practiced at a mining operation near Bluefield, West Virginia, where holes for the pipes are drilled to

depths ranging from 100 to 1000 feet, depending upon the thickness of the overburden between the coal and the surface. The pipes are sent a short distance through the collar of the holes and then connected to blowers which exhaust the gas.

Some of the mines where this is being done are extremely gassy, the Institute reports. One liberates as much as 12,000,000 cubic feet of gas a day—enough to supply a large city.

Although the amount of inflammable methane must be kept to a maximum of 0.5 percent in the mine atmosphere, it is the aim of this new gas-evacuating process to reduce the amount of methane in the mine atmosphere 50 percent before a coal seam is opened.

An idea of the economy of this method can be gained by considering that to get out 12,000,000 cubic feet of gas from the mine and bring the methane content of the atmosphere to the required maximum would mean the circulation of 300,000,000 cubic feet of air a minute by the usual means of ventilation.

POWER LINES

Can be Made to Carry Increased Power

ELECTRICITY zipping through a midget power line has demonstrated that existing transmission systems can be stepped up to carry 65 percent more power by adding one generator and thousands of small steel boxes crammed with sheets of aluminum and paper. R. D. Evans, consulting transmission engineer at Westinghouse Electric & Manufacturing Company, conducted the laboratory experiment to prove a theory he developed.

By using 7200 of the small steel boxes, called capacitors, together with the necessary generating equipment, Evans says, a 250-mile-long power line with a capacity of 175,000 kilowatts could be stepped up to carry 290,000 kilowatts. This 115,000-kilowatt increase would be sufficient to supply all the electrical needs of a city of 350,000 population.

The capacitors which would make possible this power increase are steel boxes the size of overnight bags, filled with layers of aluminum foil and paper which permit more power to flow through the wires.

These devices "tune the circuit like a condenser does in a radio," the engineer says. "Use of capacitors to increase a power line's effectiveness not only is efficient but also is the most economical way," Evans reports. Heretofore, the most common method of boosting a power line's capacity was by adding extra transmission wires, since additional electricity could not be "forced through" the old lines without the help of capacitors. The cost of an additional power line and auxiliary equipment to step up a 250-mile transmission system's capacity 65 percent would be about $4,500,000. With the 7200 capacitors necessary to step up a 250-mile-long line's capacity 65 percent, the cost would be about $1,200,000. This, it should be added, does not include a generator which would be necessary in either case.

New Products

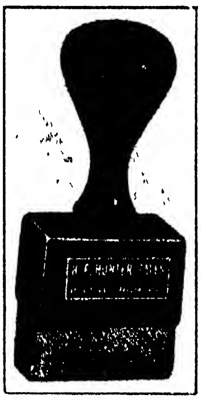
THREE-LIQUID PUMP

A SPECIAL-PURPOSE step-valve pump, developed for use in a new war process which cannot be discussed here, is a typical example of how industrial pumps are engineered to meet specific requirements and, as in this case, can often be built from units used in standard pump design.

This new Milton Roy pump, although driven by one motor, delivers three liquids—one heavy, viscous material and two very light materials—at various required rates of flow to control accurately the volume of each in a compounding operation. Features of the pump include three step-valves, one with a single cover-plate. All valves have self-cleaning double ball-checks on both inlet and discharge sides.

COMMUTATOR CLEANER

MANUFACTURED of a nonconducting abrasive compounded with soft rubber, a new hand-held commutator cleaner



A hand-held commutator cleaner that does not remove polish from brush faces

is now available. This cleaner, adaptable to use on either commutators or slip rings, will not, it is claimed, scratch or score, but leaves a clean polished surface which adds to the life of both the commutator and brushes.

STUD LOCKING SYSTEM

ENGINEERS have used threaded inserts and studs for fastening two parts together for many years but this practice has always fallen short of being entirely satisfactory. Under vibration the inserts or studs would back out or loosen, and, if a nut became frozen on a stud, the torque necessary to disengage the frozen nut invariably unscrewed the stud.

The difficult problem of permanent installation for these fastenings can now be solved by the use of the Rosán Locking System for inserts and studs

The principle of the locking system is very simple. A locking ring, serrated both inside and out, engages its inner teeth with a serrated collar on the insert or stud. The outer teeth of the locking ring broach their way into the material when struck with a hammer or a drive tool. Thus, the insert or stud becomes an integral part of the softer material, and since the inside serrations on the locking ring prevent the insert or stud from turning, and the outside serrations prevent the ring itself from turning, the whole installation becomes completely permanent. The sharp leading edges of

Demonstration of stud locking system

the serrations on the locking ring broach the material effectively, but the crests of the serrations or splines are rounded to prevent any sharp corners which might create possible points of failure in the soft material. The locking ring has a special pilot on the lower edge and its inner serrations are so designed that they easily engage with the serrations on the insert collar When fully driven into place, the ring closes in on the insert and makes a completely solid unit of the whole.

CORROSION PROOFING

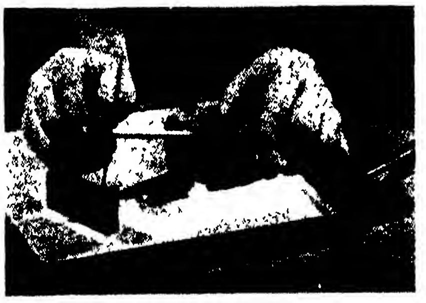
TWO coatings for ferrous metal surfaces which are ordinarily exposed to corrosion have recently been developed. One of these, known as Silco, resembles a vitreous enamel. It is applied to such surfaces as engine exhaust manifolds, mufflers, and so on, by spraying after the metal has been cleaned, pickled, rinsed, and dried. The sprayed surface is first dried and then baked, after which the finished coating will not burn off at temperatures up to 1000 degrees, Fahrenheit.

The second corrosion proofing material is known as Armor-Vit. It may be applied

either by spraying or dipping and, after baking, may be heated to 1200 degrees, Fahrenheit, without failure of the coating film.

GLASS SURFACE PLATES

SURFACE plates in heavy glass are now available in degrees of accuracy from .0002 to .0005 of an inch and in standard sizes of 8 by 8, 8 by 12, 10 by 10 and 12 by 12 inches. The use of these glass



A glass surface plate in use

surface plates is releasing, for other uses, materials that are urgently needed in war industries.

Wear, negligible since the surface of glass is very hard, is indicated by scratches and, unless they are grouped closely and densely, they do not affect the accuracy of the plate. As scratches do not burr, they will not cause surface errors The low co-efficient of expansion of glass indicates very little change due to variations in temperature.

Glass surface plates are non-conductors of electricity and will never require demagnetizing. They require no oiling of the surface as they will not corrode. The fact that they are of glass will induce greater care on the part of those who use them.

As these plates are clear, drawings or data to be referred to frequently may be placed beneath them, thus providing protection for the prints and making the data readily available. Where required, permanent records may be etched on the lower surface of the glass.

LOCKING CASTER

FREEDOM of movement is provided for scaffolding, portable work benches, and so on, by the caster shown in one of our illustrations, yet complete immovability can be obtained whenever desired through the application of the self-contained lever-

Simple lever motion locks the caster wheel

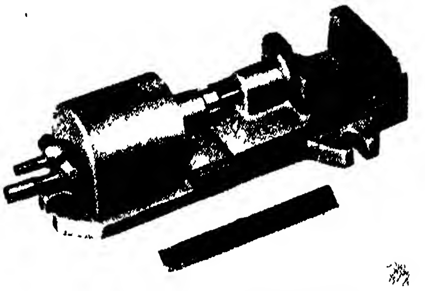
operated brake. The caster shown includes a double enclosed ball swivel, a steel fork, a roller bearing semi-steel wheel, and a cam operated brake which bears against the caster wheel when the lever is operated.

AIR VISE

THE USE of long dove tail ways for the sliding jaw of a new air-operated vise gives an exceptionally smooth action which is free from play in all directions. The long ways keep the jaws parallel, even where work is held off center, and prevent any binding action from absorbing part of the holding power. The sliding jaw can not "lift" as it closes on a cylindrical piece held horizontally.

A simple but useful feature of the Mead Air Vise is the collar provided on the ram by which the length of the stroke may be controlled to any desired length On many types of work a stroke of no more than 1/16 of an inch is needed and minimum strokes are recommended in all cases Three reasons are evident: Low air consumption; quick action; and minimum danger of pinched fingers. The adjustment is easily made with a screw driver.

In cases where a drill plate is attached to the stationary jaw, a long stroke is



May be foot- or hand-operated

sometimes needed to facilitate inserting and removing work. The two inch stroke of the vise will be found adequate to handle work of this type within the capacity of the vise.

This air vise can be furnished with either hand valve, as shown, or with one of two types of foot control valves. Model ON foot control releases work when the button is pressed and holds it at all other times. Model OFF foot control holds work while the button is held down, but leaves the jaws open at all other times. Either model ON or model OFF may be set up to be operated automatically by functional parts of the machine on which the vise is used.

REFRIGERATED WELDING

A DEVELOPMENT in resistance welding electrode design which makes possible full utilization of refrigerated welding has been announced by Frostrode Products, originators of refrigeration for resistance welding.

Aircraft manufacturers who have adopted the new "Frostpoint" as an integral part of the "Frostrode" electrode refrigerating process have already reported increases from 600 to 1000 percent

over refrigeration of conventional electrodes in the number of spot welds which can be made before the tips require "dressing."

A 90 percent saving in the copper normally required for resistance welding electrodes is forecast by the fact that the only part that needs replacing in the new "Frostpoint" is the "Frostcap," a quick-replaceable tip on the end of the welding electrode.

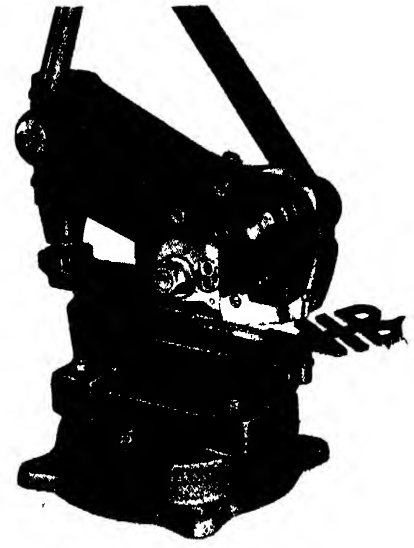
Other features of the new electrode include. Machine and hand dressing of points is completely eliminated; if a cap does mushroom, it is removed and replaced by another in about one minute's time The life of a cap without any dressing except polishing is estimated to be about equal to that of a conventional electrode re-dressed until no longer useable. The cap seals the electrode against leakage. Greater cooling area is obtained by internal integral finning of the cap. The electrodes are so constructed as to provide absolute accuracy of coolant flow control, thus insuring operation at maximum cooling efficiency at all times.

WATER LEVEL SIGNAL

A PASTE-LIKE material which is applied in a thin film to a gage stick makes possible accurate determination of the amount of water present in the bottom of a gasoline or oil storage tank. The paste is of such character that it changes from gray to deep red when in contact with water but not when it is touched only by gasoline or oil When the treated gage stick is inserted into a tank and removed, the dividing line between water and other liquid is sharp. This material, known as Detex Water Finder, is packed in 2½ ounce and 1 pint jars, the smaller jar containing sufficient material for about 500 tests.

HAND NIBBLER

DOUBLE crank construction of the hand nibbler illustrated in this column makes possible easy and rapid operation With this device, developed by the National Machine Tool Company, templates and trial blanks may be quickly cut to any desired size, thus saving costly hand operations at the bench. It is also possible to cut drill rods with the same machine or to punch holes up to ½ inch in diameter through ⅛ inch flat stock.



Nibbler and hole puncher

SPIRAL ABRASIVES

SPECIALIZED abrading and polishing jobs can be accomplished with a new abrasive strip material formed into the shapes shown in the accompanying illustration

Abrasive strips in spiral form

As shown, some of these are produced in tapered shape for their entire length while others have a base that is cylindrical in form This coated abrasive strip material is designed for application on a mandrel in stationary or portable machines

MOLDING PLASTIC

BOILING water and food stains have but little effect on a new plastic molding material known as Melmac 1077. This melamine plastic, filled with alpha cellulose, is designed for the production of tableware and similar forms The molding powder or granule is available in a range of colors.

HYDRAULIC OIL SOLVENT

A CONCENTRATED liquid known as Gum Solvent B has been developed for use in hydraulic installations When 3 to 5 percent of the concentrate is added to the oil before draining, it is claimed that all accumulated gums and sludge will be dissolved. Thus when the system is drained, the hydraulic lines, valves, and other parts of the mechanism are found to be clean without the necessity for a flushing operation

SAW-GUN

AN ATTACHMENT for electric drills, flexible shafts, or air operated drills, which has recently been developed, makes it possible to convert such tools into portable power saws or files.

The conversion is accomplished by chucking a reciprocating attachment into the drill or other power source. This attachment, which is prevented from rotating by being held in one of the operator's hands, converts the rotary motion of the primary tool into reciprocating motion of the saw blade or file secured in a holder. It is claimed that this unit will save hours of work on panel notching, slotting, or other fabricating operations in metals, plastics, plywoods, and other materials.

Helicopter Progress

Present Orders and Future Possibilities Point Toward a Fertile Field for Rotating Wing Aircraft

ALEXANDER KLEMIN
Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University

There is immense interest in the helicopter. Both American and British naval authorities have announced that the helicopter will be used for protecting freighters against the submarine, and an order for 250 helicopters has been placed with Sikorsky Aircraft Corporation. The use of rotating wing aircraft for anti-submarine work was suggested in many quarters years ago, and it is pleasing to note that the cautious conservatism of naval authorities has now been overcome. In some respects a helicopter is better equipped to fight the submarine than an airplane because it can hover over the U-boat and drop depth charges with 100 percent accuracy, and certainly the helicopter is an aircraft which can utilize the landing facilities of the deck of a 10,000-ton freighter with ease.

Then we learn that Cargoes, Inc., a subsidiary of the Lend-Lease Administration, has placed an order for two helicopters for the British Government (also for use with merchant ships) with Fleetwings, Inc., a plant which Henry J. Kaiser took over last winter. It is understood that the Kaiser helicopter will be ready in a few months and that, if it is successful, a contract for large-scale production will follow.

But it is not only for war purposes that the helicopter is likely to be useful. There is an optimistic prediction by Mr Sikorsky who thinks that speeds in excess of 120 miles an hour can be obtained by the helicopter.

"The helicopter well may be expected to become a very popular type of aircraft extensively used by private individuals in a way similar to the automobile, and also by individuals and organizations for a great variety of business and commercial assignments," Mr. Sikorsky says. "The helicopter may be a vital factor in the period of demobilization of the aircraft industry after the war, permitting the utilization of facilities and the employment of a gradually increasing part of the trained personnel which will become available. It will make possible broader and better use of the territory of this country by opening for residence, recreation, prospecting, and development areas that now remain practically idle because of transportation difficulties. All this may be foreseen with confidence and I am convinced that within a decade after the war there will be hundreds of thousands, possibly a million, helicopters in actual use in this country."

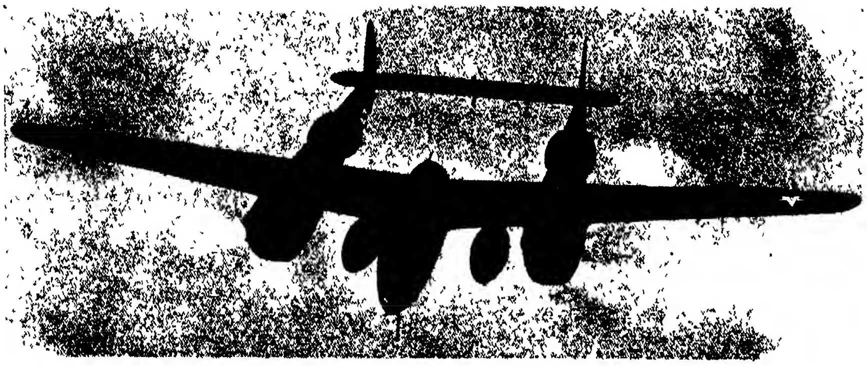
But there is a still more encouraging item of news in regard to the postwar utilization of the helicopter. Samuel J. Solomon, President of Northeast Airlines, one of the most energetic and far-sighted of the air transport operators has filed an application with the Civil Aeronautics Authority for permission to start a helicopter service. This service would carry airmail and air express to and from the rooftops of over 400 post offices and railroad stations in the six New England States and New York. The Northeast Helicopter System would augment the regular operations, and fly express not only between cities and towns, but from congested areas to the airports. Mr. Solomon became convinced of the enormous potentialities of the Sikorsky helicopter after witnessing several demonstrations, and is certain that his plan will be followed by every important airline in the country.

FUSELAGE SANDBLASTING
Used in Fabrication of Primary Training Plane

Not a deep sea diver, but a mechanic of the Boeing Airplane Company, who is sandblasting foreign particles from the hollow steel tubing which forms the fuselage of a Boeing primary trainer, is shown in the accompanying photograph.

This biplane trainer, known to the Army as the PT-17 Kaydet, and to the Navy as the N2S-3, has made quite a name for itself in World War II, in which it occupies a position akin to that


Sandblasting foreign particles from fuselage frame of a training plane



Auxiliary gasoline tanks are suspended under the Lightning's wing

of the Curtiss "Jenny" in the First World War.

The 7000th Kaydet recently was turned over to distinguished A.A.F. officers by a Boeing Company official. For primary training where low wing loading, sturdiness, and stability are more important than speed, the biplane has much to commend it.—*A.K.*

FLIGHT TRAINING
Speeded Up by
New and Simple Method

AN INTERESTING idea is being tried out for training students to fly the exceedingly fast Lockheed Lightning; the single-seater fighter with two engines and two booms to support the tail. By removing a good deal of the radio equipment, the student is able to sit in "pickaback" fashion behind the pilot's seat; he is enclosed in the pilot's cockpit, his head coming close to the pilot's shoulder where he can see all instruments and controls. The Lockheed is fast and controllable and can be put through some wonderful maneuvers. It can even be maneuvered on just one engine, but it takes experience and skill to secure complete command of the Lockheed. The student flying immediately behind the instructor can learn in one hour what might take ten hours to absorb when practicing solo.—*A K.*

GASOLINE TANKS
Increase Plane Range, Decrease
Speed Only Slightly

THE STREAMLINED gasoline tanks, which are shown mounted under the wing of the Lockheed Lightning P-38 in one of our illustrations, carry enough gasoline to double the normal range of this remarkable fighter. Yet, thanks to skilled aerodynamics, there is a loss of only 4 percent in the top speed. Doubling the range has obvious advantages when ferrying across the ocean, and in extending the range of the fighter when protecting bombers. The addition of the tanks does not hinder the fighting characteristics of the P-38, since these auxiliaries can be dropped prior to combat.

Each tank carries 165 gallons of gasoline, or 1000 pounds when full, but the weight of the tank itself is only 90 pounds in spite of the fact that it is beautifully streamlined and that a streamlined shape does not have the maximum capacity for a given weight. Hours of wind tunnel and static vibration tests went into the design. The tanks are very simply built in two half shells of "1010" body steel, .024 inches thick. The rate of production is quite remarkable, as one tank is turned out every four minutes, and the cost is now under one hundred dollars. Clever spot and seam welding equipment, and conveyor methods in welding and assembly have facilitated production, with a regular sequence of operation on the conveyor line. Although space does not permit a description of the fabrication process, conveyor lines and production methods, once generally the prerogative of the automobile industry, have now been adopted, and even improved, in the aircraft industry. A recent visit to an airplane plant has convinced us that miracles of production are being achieved by our aviation men.—*A.K.*

WOODEN AIRCRAFT PROBLEMS
Are Completely Different
from Metal Problems

A GREAT deal has been heard by the public on the replacement of aluminum by wood, of the success of the Mosquito bombers (built of wood) flying over Germany, and the like. Yet, at the same time, wood structures have in the past year acquired somewhat of a poor reputation in static strength tests. Is this because wood is unsuitable for large aircraft construction?

At a meeting of The Society of Automotive Engineers, Ivar C. Peterson faced the problem squarely, and discussed the various difficulties that have arisen.

Wood is not an inorganic material like steel, but an organic one whose properties vary from log to log. Its strength properties also vary with moisture, and this sometimes is not properly taken into account. Moisture causes variation in strength, and also produces shrinking and swelling. Metals, of course, present no such difficulty.

Glued joints naturally play a large part in aircraft construction and here there must be a sufficient spread of glue on smooth wood surfaces, and just the correct temperature, pressure, and glue consistency at the time pressure is applied in the glue joint. The gluing operations require more skill and thought than riveting or welding in metal construction. Sometimes is it very tempting to use high and low density woods in combination, particu-

larly in highly stressed points of the airplane. But the elastic properties of high and low strength woods are different and troubles arise accordingly, owing to the elastic incompatability of the two woods. Other difficulties arise when there is a great stress concentration in the wood.

Mr. Peterson's conclusion, and it is one with which we thoroughly agree, is that wood and plywood are perfectly suitable for aircraft construction; if their use has caused any difficulties of late, these are due to the fact that detail design and handling have not been properly understood, and because wooden aircraft have been constructed by factories new to the airplane art.

With all due precautions, and when construction is in the hands of skilled or well trained new workers in wood, these difficulties will largely disappear.—*A. K.*

TIRE REMOVAL
Made Easy by New Device

OUR AIRLINES are beautifully organized and splendidly run, some of the success in this direction being due to the fact that conferences by mechanics are greatly encouraged. A mechanic employed by

Safety in airplane tire removal

United Airlines, W. H. Pitts, was awarded several war bonds by the United Airlines Suggestion Committee for the device illustrated in one of our photographs. This is a tire-removing tool which has become standard equipment throughout the United system. The device, which consists of a steel frame and a hydraulic jack, facilitates the removal of tires without damage to either tire or wheel.—*A. K.*

GLIDERS
Proposed to Assist Take-Off

WORD comes from Washington of a patent granted to Vladimir S. Makaroff in which it is proposed that a heavily loaded bomber or transport should be assisted off the ground by means of a glider fastened to its back. We have been asked whether the idea is sound.

It is plausible. When the powered airplane and the glider are hitched together, they form a biplane of greater wing area than the monoplane which constitutes the powered plane. Since the glider can be light in construction for this specific purpose, it is clear that the average wing loading of the combined craft will be low, and with low wing loading there should be a quicker, easier take-off. Of course, the glider has drag, and the mechanism locking the two together also adds drag and weight. Therefore, in spite of the plausibility of the idea, very careful analysis would have to be carried out before it could be accepted completely.

Readers may remember the composite airplane invented and tried out by Major Mayo in England; there is a certain resemblance beteeen the two ideas. But Major Mayo had a small, heavily loaded airplane mounted on top of a large one, so that the large airplane could help the overloaded smaller airplane get into the air. Of course, Major Mayo was also experimenting with assisted take-off, but in his device each craft had its own power-plants.

Assisted take-off has been suggested again and again in a variety of forms: compressed air catapult, powder catapult, winches and cables hauling a plane along, rocket or jet propulsion, have all been discussed as possible means. But none of them has been generally adopted, because the growing power of our engines has reached such a figure as to make assisted take-off unnecessary. Only for launching airplanes off the deck of a ship have catapults remained. But that does not mean that assisted take-off will not be with us sooner or later, at least for specialized purposes.—*A. K.*

DESIGN DETAIL
Needed to Keep Fighting Planes in Trim

IN A RECENT paper presented before the Society of Automotive Engineers, N. L. Kearney, Service Manager of Curtiss-Wright Corporation, reminds us that only those airplanes can fight which are properly maintained and repaired. Mr. Kearney expressed hope that the designers of our fighter airplanes will give greater thought to ease of maintenance, and to the problems of those men whose job it is to keep airplanes in flying and fighting condition. When the Army field mechanic finds that before he can remove and service a propeller speed governor, he has to remove the propeller itself at the cost of two or three hours extra time, his explosive language may well be forgiven. A great deal of progress has been made from a maintenance point of view in recent years—fewer disconnections in removing a unit, fewer cowl fasteners, more quickly replaceable wing tips, and so on, have been introduced.

Another important matter is the thorough training of field personnel in the proper servicing and handling of aircraft. Tools and spare parts are of the utmost importance and a lack of spares can keep a tremendous number of airplanes on the ground.—*A. K.*

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

THE FIVE COMMERCIAL TYPES OF SYNTHETIC RUBBER is a 40-page illustrated booklet designed to present a relatively brief resume of a comprehensive subject. The data presented will serve as background material for understanding the general possibilities of various synthetics. *United States Rubber Company, 1230 Sixth Avenue, New York, New York—Gratis.*

FLUORESCENT MAINTENANCE is a 20-page pocket-size pamphlet which shows, in illustration and text, how to get the best performance out of industrial lighting systems which employ fluorescent tubes. Hints are given on trouble shooting and on checking lamps and equipment. *Sylvania Electric Products Inc., Salem, Massachusetts.—Gratis.*

BETTER BRUSH SPRINGS is a ten-page illustrated catalog which describes the advantages of beryllium copper brush springs and their effect on small motor performance. *Instrument Specialties Company, Inc., Little Falls, New Jersey.—Gratis.*

INDUSTRIAL FORMS is a 12-page booklet illustrating and describing a number of forms which have been specifically designed to aid in recording data obtained as a result of time and motion studies, operation analyses, production control, and so on. *Methods Engineering Council, Wood and Franklin Streets, Pittsburgh, (21), Pennsylvania.—Gratis.*

VARIABLE SPEED TRANSMISSION is a 16-page illustrated catalog describing a variable speed mechanism and gear reducer built in a single compact unit. These transmissions meet the many important requirements for accurate variable speed control of industrial machines. Request Catalog TR-432. *Reeves Pulley Company, Inc., Columbus, Indiana.—Gratis.*

BATTLENECKS is an elaborately produced pamphlet printed in many colors—including metallic inks—which tells the story of materials, machines, and men in their relation to industrial production for war. Designed to encourage and speed operations on the production front. *Major General T. J. Hayes, Jr., Chief of Industrial Division, Ordnance Department, Pentagon Building, Washington, D. C.—Gratis.*

LUCITE MANUAL is a 126-page pocket size book describing various general methods of fabricating Lucite methyl methacrylate resin which have been found satisfactory in industrial operation. Information is given on the chemical, physical, and mechanical characteristics of Lucite, care and handling, machining, shaping, finishing, and so on. *E. I. du Pont de Nemours, 624 Schuyler Avenue, Arlington, New Jersey.—Gratis. Request this book on your business letterhead.*

TIMBER CONNECTORS is a four-page folder which describes a type of split-ring timber joint connector now being satisfactorily applied in various types of structures. Specifications are given on the kinds and on methods of application. *Carlson Building Specialties, 3234 West 31st Street, Chicago, Illinois.—Gratis.*

SOUTH BEND LATHES (Catalog 100-C) is a 48-page brochure illustrating and describing in detail the entire line of engine lathes, toolroom lathes, and turret lathes manufactured by this one company. Specifications are tabulated to facilitate consideration of the lathe needed for any desired application. *South Bend Lathe Works, South Bend, Indiana.—Gratis.*

HOW "CATERPILLAR" HELPS FIGHT WORLD WAR II is a 56-page story, mostly in pictures, of the work which this type of prime mover is doing in all phases of wartime operations, from the construction of airports and other engineering projects to the actual movement of men and materiel. *Caterpillar Tractor Company, Peoria, Illinois.—Gratis.*

CALIFORNIA REDWOOD—ITS PROPERTIES AND USES is a colorful four-page circular discussing the physical, mechanical, and chemical properties of this wood. *California Redwood Association, 407 Montgomery Street, San Francisco, California.—Gratis.*

SPECIAL COATINGS AND CEMENTS is a folder describing a number of adhesives and coatings which have been satisfactorily tested for actual production requirements. Uses for these materials range from barrage balloon cementing to shoe lace tips, jungle tents, and rubber mats. *Union Bay State Company, 50 Harvard Street, Cambridge, Massachusetts.—Gratis.*

THE STORY OF STEINMETZ is a short illustrated biography of Charles Proteus Steinmetz, the great mathematical wizard of electrical engineering whose work helped to make possible a great industry of today. Bulletin GEB-104B. *Publicity Department, General Electric Company, Schenectady, New York.—Gratis.*

PLASTIC PARTS FOR WAR PRODUCTION is a folded sheet showing examples of plastic parts made to order and to close tolerances through new fabricating techniques which eliminate the use of expensive molds. *Creative Plastics Corporation, 963 Kent Avenue, Brooklyn, New York.—Gratis.*

TUBE PICTURE BOOK consists of 16 large (17 by 22 inches) pages containing eight charts which show structural details of representative receiving, transmitting, cathode ray, and special vacuum tubes. Distribution limited to United States and Canada. *RCA Victor Division of Radio Corporation of America, Harrison, New Jersey.—Ten Cents.*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

THIS MONTH, let's turn over the meeting to the math sharks. For the rest of us, what follows may have to be taken in low gear.

In this department in September, 1942, Capt. Alan E. Gee described his solution of the old problem of testing a Cassegrainian secondary. He proposed to grind and fine-grind the convex mirror to a sphere; then set it aside and polish, or partly polish, the concave tool; next, figure this concave tool to the required hyperboloid, using the formula at the top in Figure 1 with the Foucault test. Finally, figure and test the convex against this prepared concave by means of interference fringes.

Commenting on this proposal, F. A. Lucy, 3427 W. Penn St., Philadelphia, Pa., writes: "Capt. Gee's method of figuring a Cassegrainian secondary, appears to be the best yet offered, and deserves all the emphasis that can be given it.

"Hindle's test for an hyperboloid ('A.T.M.' Part X) has advantages over Ritchey's autocollimation method: it shows more of the mirror surface and is less troubled by diffraction effects. Further, there is only one auxiliary surface instead of two. Gee's test has the same advantages more strongly: it shows *all* the mirror surface, is still less troubled by diffraction, and uses no auxiliary surfaces, except insofar as the test-plate is considered one.

"It is true that the tests of Hindle and Ritchey employ a double reflection from the mirror, thus doubling the sensitivity, but a test-plate set up for Gee's test will be much closer to the knife-edge and, therefore, will have a larger apparent angular diameter.

"Geometrically, then, the tests are about equal in sensitivity but, as a matter of psychology, it is easier to judge contrasts in a large field.

"On the whole, finally, Gee's method appears to be capable of yielding the most accurate results of any.

"In like manner, an ellipsoidal mirror (for example, a Gregorian secondary) will appear more than twice as large when set up for c. of c. testing as when set up for the direct focal test—again with the least possible trouble from diffraction. Because of its greater speed, the direct focal method might be preferable for preliminary figuring, reserving the zonal survey for final work.

"With regard to the application of this test to convertible telescopes, a compound telescope is generally made with a paraboloidal primary of fairly large focal ratio, so that it may be used at the primary focus when desired. For looking at lunar or planetary detail, or for resolving close stars, the compound system is, however, preferable. The necessary high magnification can be obtained by using a short-focus paraboloid and a sufficiently small eyepiece; but if the latter has a Ramsden disk less than 2mm in diameter, the resolving power of the eye is reduced, and the use of still smaller eyepieces will give less detail rather than more in the image. It is better to use an objective of long focal length. If compactness is to be maintained, the Cassegrainian arrangement is generally considered the best way of doing this.

"While the classical Gregorian arrangement is less advantageous than the Cassegrainian, an off-axis Gregorian would be superior in at least one way to an off-axis Cassegrainian. In the Gregorian, the active part of the secondary will be below the axis when the active part of the primary is above. Thus the primary can lie very close to the axis with no shadowing at all by the secondary. An off-axis Gregorian, indeed, can be made even closer to the axis than can an analogous Newtonian; thus securing the advantages (A. A. Michelson, *Physical Review, 20,* 391 [1905]; N. J. Schell, Sci. Am. Telescoptics, April 1939, May, 1940) of this type (no shadowing, minimum diffraction) with the least extreme focal ratios and least difficulty in figuring. Incidentally, Gregory's original design has the eyepiece a considerable distance behind the primary, with a tube long enough and narrow enough so that direct sky light is kept from striking the eyepiece: the secondary shades it. This detail usually appears to be neglected in diagrams of the Gregorian construction.

"It follows that the convertible telescope of best performance would be an off-axis Gregorian with paraboloidal primary; although it would be easier to figure an on-axis Cassegrainian. In either case, the equations of Selby and Gee offer the best guide to the figuring (see below)."

When Capt. Gee first offered his data he included a mathematical proof, but this was not published—complicated formula matter is difficult to set correctly in type. Now comes Lucy with a condensed derivation, which follows. In it, the numbers in parenthesis refer to the numbered equations in Figure 1, written out by Lucy and reproduced by line-cut (one way to get around the above problem, mathematician-compositors apparently having all marched off to war). Lucy states:

"From a text on analytic geometry, one sees that, measured from the center of an hyperboloid, the x intercept of the normal is (1), where (x_2, y_2) is the zone on the test-glass through which the normal passes. The fundamental equation of the hyperbola is (2).

"Substituting (2) in (1) gives an equation for the intercept as a function of the zonal radius y_2. In discussions of mirrors, y_2 is usually called r, and will be below. As design constants, it is convenient to use, not the semi-axes a and b, but p and p', the latter two being respectively the distances from the secondary vertex to the primary focus and to the focus of the combined mirrors.

"By construction, (3) follows:

"Referring again to a text on analytic geometry, one sees that $a^2 + b^2$ is the square of the distance between the center and a focus. By construction, and with the use of (3), we have (4).

"With these substitutions, Capt. Gee obtains an equation for the radius of curvature (in the sense of the Foucault test). Going a step further, one may subtract $R_0 = 2p'p/(p' - p)$, the radius of curvature for the central zone. Reduction gives directly the knife-edge displacement for the zone of radius r (5).

$$R = \frac{p - p'}{2} + \frac{(p'+p)^2\sqrt{p'p + r^2}}{2(p'-p)\sqrt{p'p}}$$

$$x_0 = \frac{(a^2+b^2)x_2}{a^2} \qquad (1)$$

$$x_2 = \frac{a\sqrt{y_2^2+b^2}}{b} \qquad (2)$$

$$a = \frac{(p'-p)}{2} \qquad (3)$$

$$b = \sqrt{p'p} \qquad (4)$$

$$R - R_0 = \frac{(p'+p)^2\left[\sqrt{r^2+p'p} - \sqrt{p'p}\right]}{2(p'-p)\sqrt{p'p}} \qquad (5)$$

***Figure 1:* Derivation formulas**

"This is for use with a testing set-up in which light source and knife-edge move together. If the knife-edge moves while the light source is stationary, the displacements are doubled, and the 2 in the denominator of (5) should be cancelled.

"H. H. Selby ('A.T.M.A.,' p. 134) has already given the corresponding equation for an ellipsoidal mirror. His equation may be derived by the process just described, using the ellipse analogues of (1), (2), and (3). The foregoing equations are all exact."

Subsequent to receipt of the above note by Lucy, there came from Captain (now Major) Gee, Corps of Engineers, APO 702, care of Postmaster, Seattle, Wash., the following communication.

"In the June, 1938, number of Scientific American, Kirkham furnished equations and dope concerning the construction of Cassegrainians with spherical secondaries and modified primaries of predetermined amount of spherical aberration to match. MacIntosh, Conner, and I applied this method to the 20½" telescope we made in Portland, also to a 12½" telescope now being completed there. On both of these telescopes I am interested in making high-

magnification secondaries to use alternately with the 3× secondaries for which both instruments were designed. With this in mind, I have worked out the necessary math to determine difference in radii of curvature of the zones of such a secondary, as measured by the King test or on the polished tool (for test of the convex by interference fringes). My equations are general and simple, so the dope may be of use to other ATMs who desire alternate secondaries for their modified Cassegrainians.

"Let a_1 be the spherical aberration of the primary (this would have been determined by Kirkham's equation when designing the original telescope); r_2 the radius of the new secondary to the margin of the area reached by light incident parallel to the axis; p' the distance from new secondary to secondary focus; and p the distance from new secondary to prime focus. Then

"$R = (2p'p)/(p'-p) =$ radius of curvature of new secondary (actually R of central zone) and $a_2 = [(R+p')^2/(R+2p')^2]\ r_2^2\ R$. (The formulas are recast somewhat to permit them to be set on a linotype machine.—*Ed.*)

"Desired knife-edge movement between edge zone and central zone of new secondary then is $d' = \Delta a\ R^2/p^2$, where $\Delta a = a_1 - a_2$.

"The above equations are all derived for direct substitution of absolute values. In other words a_1, r, p', p, R, and a_2 are all positive values.

"If a_1 is greater than a_2, edge zone will have shorter R than center zone If a_1 is less than a_2, edge zone will have longer R than center zone.

"Derivation assumes a stationary pinhole and moving knife-edge or grating.

"For intermediate zones, measured correction is proportional to square of the radius of the zone; that is, for a zone half way between center and edge, one fourth of the correction, $d'/4$, would be applied.

"The curve on these secondaries would approximate an oblate spheroid on secondaries smaller than the one for which the primary was designed, and a prolate spheroid for secondaries larger than the original.

"The above method could be applied to make a secondary for a Cass with spherical primary. In that case $a_1 = r^2/4R$, where r is the marginal radius of primary and R the radius of curvature of primary Secondary would approximate an oblate spheroid.

"It is actually possible to make a properly corrected telescope with both primary and secondary spherical but, unfortunately, the proportions are highly impractical.

"Here is one more suggestion. Some ATMs who have conventional *f*/8 or *f*/10 Newtonians could convert them into RFTs by making a concave secondary for them to be placed inside focus. For a paraboloidal primary, the secondary hyperboloidal and the various knife-edge readings would be given by the equation I furnished in the September, 1942, number (first equation, Figure 1). For this special case, p' would be the distance from secondary to prime focus, and p the distance from secondary to secondary focus (just the reverse of the usual Ritchey notations). $R = (2p'p)/(p'-p)$ would still give the radius of curvature

"If it were desired deliberately to introduce spherical aberration to correct for RFT eyepiece aberration, as suggested by Kirkman, my equation $d' = \Delta a\ R^2/p^2$ would give the change in zonal readings to be applied to the readings for the exact hyperboloid. This additional Δa would equal the desired aberration in that case. Care should be taken to see that the correction is applied in the right direction"

Maj. Gee's comments were next shown to Lucy, who then added:

"His equation for the hyperboloid to be used with a given paraboloid is exact: whereas the corrections in the modified cases are approximate For that matter, Kirkham's equation is also approximate, as Kirkham himself made clear. The adequacy of the approximation depends on the size of the telescope, the focal ratio of the elements used, and on the severity of the selected tolerances. A modified telescope, made precisely to these equations, might require further correction by the aid of optical tests on the assembled instrument

"I should be interested in hearing how these modified Cassegrainians actually perform when first assembled, especially when they are made to the extreme specifications of the Walkden RFT ("one-gallon" Cassegrainian)."

By accident, your scribe has just discovered that Lucy is the author of a two-part, eight-page article entitled "Exact and Approximate Computation of Schmidt Cameras," *Journal of the Optical Society of America*, June 1940 and May 1941 In this two-part article, the first half discusses the Schmidt design in a mathematical manner, while the second part discusses several modifications: a reversed plate Schmidt, solid Schmidt, thick-mirror Schmidt Your scribe is collecting names of ATMs who go in for the math stuff. Such a group might become a sort of "Design Club," not formally organized but at least kept in closer mutual touch than at present, simply by being made known to each other.

ATMs HAVE asked this department about the content of some sets of salvaged lenses advertised elsewhere (page 275) in the June number The Edmund Salvage Co. kindly gave us the requested data and a 70-lens set for inspection. The first set contains two lenses, 31mm diameter and 92mm f.l.; two 33 x 221 ditto; two 37 x 393 ditto; two 42 x 152 ditto; two 18 x 50 biconvex; two 17 x 58 plano-concave; two 14 x 35 ditto; and one 14 x 33 biconvex

The second set contains all of the above, plus one each of: 9 x 36; 12 x 46; 16 x 238; 17 x 92; 24 x 92; 28 x 99; 28 x 136; 31 x 127; 31 x 152; 42 x 174; 42 x 201; 49 x 238; 54 x 201—all plano-convex. Also three biconvexes: 16 x 50; 22 x 45; 22 x 53; four plano-concaves: 12 x 148; 13 x 34; 13 x 55, and 24 x 148; two biconcaves: 19 x 30 and 19 x 50; and three menisci: 10 x 51; 28 x 120 and 33 x 120.

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with the names of available books, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for. Books listed in these columns may be ordered from our Book Department. Add 25 cents per book for mailing outside U. S.

FOR THE PERMANENT VICTORY

By Melvin M. Johnson, Jr. and Charles T. Haven

A DISCUSSION of the future, based on the past, from the standpoint of America, as the arsenal of peace. Not a complaint, but a constructive analysis on which a safer, better future can be built. After describing America's military strength and weaknesses in all her wars, a future plan is outlined. This emphasizes that, without becoming a militaristic nation, we should ever maintain a nucleus of modern war industries and a corps of trained men to operate them. Ably written by two men who know armament: The first is a Captain in the United States Marine Corps Réserve and inventor and producer of the Johnson light machine gun and Johnson Automatic Rifle; second is co-author of "History of the Colt Revolver" and other books on firearms. (246 pages, 5 by 8 inches, illustrated.) — $2.60 postpaid. — *A. D. R., IV.*

DICTIONARY OF SCIENCE AND TECHNOLOGY

By Maxim Newmark, Ph.D.

HELP for translators of scientific and technological English, French, German, and Spanish. Author is in the Department of Modern Languages at Brooklyn Technical High School, also does professional translating. Coverage embraces 45,000 terms in machine shop practice, foundry, electrical physics, radio, aeronautics, architecture, surveying, automobiles, meteorology, navigation, photography, and others, and each English term's equivalent is given in three other tongues including the American. There also are indexes for French, German, and Spanish technical terms. (386 pages, 6 by 9 inches.)—$6.10 postpaid.—*A.G.I.*

CALCULUS MADE EASY

By Silvanus P. Thompson

CLASSIC work, published early in the century, long out of print and now fortunately reprinted to meet current demand for a mathematical crutch book. The famous scientist author wrote: "Being myself a remarkably stupid fellow, I have had to unteach myself the difficulties, and now beg to present my fellow fools the parts that are not hard. What one fool can do another can." He removed the pretentious terminologies from the old-fashioned textbook treatment and the book was immediately successful. Now again available to lonely sufferers with calculus. Pre-requisites: Algebra, geometry, trigonometry. (310 pages, 4¾ by 6¾ inches, 69 figures.)—$2.10 postpaid.—*A.G.I.*

GUN DOGS AFIELD

By Horace Lytle

ANY "DOG BOOK" by this author should need no introduction—its mere mention, as a product of this writer, will highly recommend it to all who, for years, have known his writings, both in other books and as Gun Dog Editor of *Field & Stream*. With the typical Lytle touch, this publication speaks eloquently of what is deep in the heart of every true hunter. Superb drawings by Lynn Bogue Hunt. (277 pages, 6 by 9¼ inches, 30 illustrations.)—$5 10 postpaid.—*A.D.R., IV.*

FROM COPERNICUS TO EINSTEIN

By Hans Reichenbach

HISTORY of ideas and discoveries connected with the relativity theory. Short chapters on the Copernicus world view, the old ether concept, special and general relativity, space and time. (123 pages, 6 by 9¼ inches, 11 illustrations.) —$2.10 postpaid.—*A.G.I.*

AMERICAN SHIP MODELS

By V. R. Grimwood

PLANS FOR such picturesque crafts as a gundalow, anchor boy, bogeye, brig of war, ship sloop, privateer ship, Chesapeake skipjack, and whaling scow, and Colonial fishing schooners. Excellent instruction and reference for builders of ship models, with chapters on: Construction of a Half-Hull Ship Model; The Building of a Whole-Hull Model; Twelve American Sailing Vessels; Rigging; Gear and Furniture; Tools and Materials; and appendices on Recommended Readings for Ship-Model Builders, Glossary, and Index. (187 pages, 7¼ by 10 inches, with 14 diagramatic plates.)—$6.10 postpaid.—*A. D. R.. IV.*

FUN WITH YOUR MICROSCOPE

By Raymond F. Yates

PRACTICAL book for beginners using the inexpensive ($2.50 to $50.00) non-professional instruments of 100 or 200 powers, nowadays seen in store windows. It explains microscope principles and tells how to make a small water-drop microscope; how to find, prepare, and mount

specimens; how to make photomicrographs and micro-projectors (home-made apparatus); and, in general, how to get started simply and inexpensively by making one's own accessories. Short but all-around. (150 pages, 5 by 7½ inches, 72 illustrations.)—$2.10 postpaid.—*A.G.I.*

JULES VERNE

By George H. Waltz, Jr.

LIFE story of an author who needs no introduction to readers older than about 35. Contains a list of the "Extraordinary Voyages" (story titles) 1863-1905. How many of these stories did you once read, and how would you like to read them again! (223 pages, 5½ by 8¼ inches, 12 illustrations.)—$2.60 postpaid.—*A.G.I.*

EXCERPTS: INTERNATIONAL CODE OF SIGNALS

WITH SPECIAL Navy flags and pennants, in color, this is the standard guide in meeting signaling requirements of Licensed Deck Officers' examination and qualifications as signalmen. Contains sections on general and Morse methods of signaling; flag, flashlight, and sound signals; the semaphore alphabet; sample pages from the Berne List, Lloyd's Register of Shipping; signal letters of the United States Merchant Marine, call letters, ship's name, particulars of classification, ownership, and other data. Invaluable for men in Navy, Coast Guard, or Merchant Marine service; an excellent reference. Paper covered. (88 pages, 5½ by 8½ inches.)—$.55 postpaid.—*A. D. R.*

RED CROSS HOME NURSING

By Lona L. Trott, R. N., B. S.

THE American Red Cross standard textbook. Most recent of numerous editions and the result of much experience. (431 pages, 5 by 7¾ inches, illustrated.)—$.70 postpaid, paper. $1.20, cloth.—*A.G.I.*

MIRACLES OF MILITARY MEDICINE

By Albert Q. Maisel

ABOUT the drugs, devices, and techniques used in the services. Shock, the ex-killer; Dr. Trueta's closed plaster treatment of compound fracture; Dr. Moorhead's electric bullet locator; new treatments for burns; plastic surgery for the defaced; toxoids for tetanus; brain surgery; atabrine for malaria, sulfa drugs; new magic of local anesthesia; flying doctors. A popular account. (373 pages, 5½ by 8½ inches, unillustrated.) —$2.85 postpaid.—*A.G.I.*

THE HORMONES IN HUMAN REPRODUCTION

By George W. Corner

BASICS of human reproduction, with a comprehensive account of the nature and function of hormones in its processes. This is not, however, one of the current sexology books; rather it is a book for those interested in the reproductive phenomena of the organism as biology. The treatment would be light reading for biologists; normal reading for others having studious habits; a bit hard going

The Editors Recommend

Best Sellers in Science

PLASTICS — *By J. H. Dubois.* Meaty information on the whole general subject of plastics, presented in narrative form for easy reading. Tabulations of properties of plastics, plus basic design information, for laymen and technicians alike. **$3.10**

EXPERIMENTAL ELECTRONICS — *By Ralph H. Muller, R. L. Garman, and M. E. Droz.* A solid book of eminently practical information on the characteristics and non-communication applications of electron tubes. The text describes experiments and presents results. For students, radio engineers, communications experts, and the serious general reader. **$4.75**

HOW TO READ ELECTRICAL BLUEPRINTS — *By Gilbert M. Heine and Carl H. Dunlap.* A chapter on how blueprints are made, plus nine other sections, each of which is devoted to a specialized part of the electrical field, from bell and signal wiring through motor control diagrams to power station blueprints. **$3.10**

GET TOUGH! — *By Capt. W. E. Fairbairn.* How to-win-in-hand-to-hand-fighting directions, by a man who really knows rough-and-tumble methods that are *not* "clean" fighting but *are* designed to win. **$1.10**

A COMPREHENSIVE SMALL ARMS MANUAL — *By Charles T. Haven.* Prepared to acquaint State Guards, Regular Police Depts., Coast Guard Auxiliaries, Plant Guards, Auxiliary Police Depts., and civilians with the operation, care, and limitations of weapons at present available for these types of defense and protective units. Discussion of all types of military and sporting rifles, shotguns, submachine guns, pistols, and revolvers, as well as their care, use, and ammunition. **$1.60**

TECHNIQUE OF PLYWOOD — *By Charles B. Norris.* Technical information on all phases of plywood manufacture and use, compiled for engineers, designers, and users of plywood. Important to many phases of wartime housing and manufacturing problems. **$2.50**

FUNDAMENTALS OF RADIO — *By Jordan, Osterbrock, Pumphery, and Smoby.* With this one volume alone, and with some diligence of application, it is possible to obtain a thorough grounding in radio principles. In thoroughness of treatment, with due respect for the needs of the reader, this book is outstanding. **$5.10**

POPULAR MATHEMATICS—*By Denning Miller.* Anodyne for those who have mathematical indigestion. Ground treated is arithmetic, geometry, algebra, analytical geometry, trigonometry, conic sections, solid geometry, spherical trigonometry, calculus. The coverage is not complete, it is rather, a collateral book and good friend **$3.85**

ELEMENTS OF ORDNANCE — A textbook prepared for cadets of the United States Military Academy. Covers manufacture, the chemistry of explosives, types of weapons, mathematics of ballistics, etc. **$6.60**

AIRCRAFT INSTRUMENTS — *By George Ellis Irvin.* All types of instruments for aircraft use described for students, pilots, inspectors. Fundamentals, instructions. **$5.10**

PLANE TRIGONOMETRY MADE PLAIN — *by Albert B. Carson.* The emphasis in this book, by an author who has tried to make the subject as painless as possible, is on practical applications rather than on mental gymnastics. A good book for the home user who wants to brush up on trig. **$2.85**

MACHINERY'S HANDBOOK—*Eleventh Edition.* "Bible of the mechanical industry," enlarged to 1815 pages of latest standards, data, and information required daily in the shop and drafting room. **$6.10**

PROCEDURES IN EXPERIMENTAL PHYSICS — *By John Strong, Ph.D.* A wealth of useful data of a practical kind for the constructor, experimenter, and skilled craftsman. **$6.80**

STEEL SQUARE POCKET BOOK — *By Dwight L. Stoddard.* Practical methods of using the carpenter's steel square for layout work of all kinds. Time-tried methods used by two generations of carpenters and found both rapid and accurate. **$1.00**

NORTON'S STAR ATLAS AND TELESCOPIC HANDBOOK — *By Norton and Inglis.* An old standby and most commonly used atlas for telescopes without setting circles. 18 maps and 65 pages of compact notes and tables. **$5.00**

WORKING WITH THE MICROSCOPE — *By Julian D. Corrington.* For the serious beginner. Explicit, practical. **$3.60**

TOOL MAKING — *By C. B. Cole.* Instructions for making and using all kinds, from personal tools to arbor presses, lathes, planers, etc., in different metals. **$3.60**

THE ELECTRON MICROSCOPE — *By Burton and Kohl.* A well-written account of this newest tool of science, with all technicalities explained for complete understanding by average persons. **$3.95**

ENCYCLOPEDIA OF KNOTS AND FANCY ROPE WORK — *By Granmont and Hensel.* More knots are described in this remarkable book than in any book on seamanship ever published or dreamed of. 3257 knots are illustrated in half-tone reproduction and are described in the text. **$5.10**

PLANT PROTECTION — *By E. A. Shurman.* All information necessary for those who would establish or belong to a plant protection group. **$2.10**

A MARRIAGE MANUAL — *By Hannah M. Stone, M.D., and Abraham Stone, M.D.* A practical guide to sex and marriage, covering fitness for marriage, mechanism of reproduction, prevention of conception, and similar vital subjects. Answers questions most often asked these authors by their consultants **$2.95**

PLASTICS, PROBLEMS AND PROCESSES — *By Mansperger and Pepper.* The whole story of plastics, including a resume of manufacturing processes and a number of thorough-going chapters devoted to plastic uses. **$3.10**

AUTOMATIC ARMS — *By Melvin M. Johnson and Charles T. Haven.* Comprehensively covers machine guns, machine rifles, sub machine guns, pocket pistols, shotguns, sporting, military rifles in automatic classification. **$5.10**

BASIC FIELD MANUAL, INFANTRY DRILL REGULATIONS. Practical working manual for commissioned, non commissioned officers. **$.50**

HANDBOOK OF CHEMISTRY AND PHYSICS — A classic reference book recently revised and brought up-to-date to keep pace with recent research. Includes material on all branches of chemistry, physics, and allied sciences. Used in laboratories and by engineers throughout the country. Flexible binding. 2503 pages. **$4.10**

ATOMIC ARTILLERY — *By John Kellock Robertson.* Electrons, protons, positrons, photons, neutrons, and cosmic rays, all described for the layman in plain language. Also transmutation of the elements and the manufacture of artificial radioactivity. **$2.35**

● The above prices are postpaid in the United States. Add, on foreign orders, 25¢ for postage on each book, except as noted. ●

For Sale by: July, 1943

SCIENTIFIC AMERICAN, 24 West 40th Street, New York City

I enclose $.... for which please forward at once the following books:

....

....

....

Name ....

Address ....

Write us for information on books on any subject. We can supply any book in print.

BOOKS

for most others. The author is a noted Johns Hopkins anatomist. (265 pages, 5½ by 8½ inches, 56 illustrations.)—$2.85 postpaid.—*A.G.I.*

BASIC PRINCIPLES OF WEATHER FORECASTING

By Victor P. Starr

BASED on modern methods used at the Institute of Meteorology, University of Chicago, where the author is professor, this systematic technical treatise assumes a previous knowledge of meteorology and is mainly for 26-hour forecasting, but five-day methods are not neglected. (299 pages, 6 by 9¼ inches, 126 illustrations.) —$3.10 postpaid.—*A.G.I.*

KNOW YOUR NAVY NOW!

By Lt. Francis A. Ford U.S.N. (Ret.)

THROUGH question and answer method a simple and accurate resume of items about the Navy for the average American whether in or out of service Seven sections cover: Navy Enlisted Men; Ships; Your Navy; Navy Expressions; U. S. Marine Corps; U. S. Naval Academy; Navy Officers. An excellent paper-covered pocket guide (84 pages, 5 by 7 inches, illustrated.)—$1.10 postpaid.—*A. D. R.*

COLLEGE PHYSICS

By Henry A. Perkins, Sc.D.

REVISED second edition (unabridged) of college textbook whose strong point is emphasis on the difficult portions; on the old physics instead of modern corpusalar physics; and on principles rather than concrete phenomena. In other words, a book for those who like to dig under, not flit over physics (802 pages, 6 by 9 inches, 596 illustrations.)—$6.10 postpaid. *A.G.I.*

CLIMATOLOGY

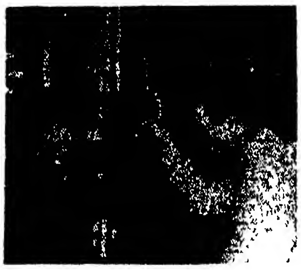
By Thomas A. Blair

PRINCIPLES, not of weather science, but of climatology, general and regional. Temperature, pressure, wind moisture as climatic elements; controls that determine regional climates; climatic variability; climatic influences; classifications of climates—these occupy about one third of the book and the remainder consists of descriptions, one by one, of the climates of the many major climatic regions of the earth. Author is Senior Meteorologist, United States Weather Bureau. (484 pages, 6 by 9 inches, 102 illustrations.)—$5.10 postpaid.—*A.G.I.*

THE OCEANS

By Sverdrup, Johnson, and Fleming

BIG, thick, text-book treatise of the science of oceanography from physical, chemical, and general biological angles. It is simple enough for the tyro but sufficiently detailed to satisfy the specialist. Authoritative—the authors are professors of oceanography at the University of California. (1060 pages, 6 by 9 inches, 272 illustrations and charts.)—$10.15 postpaid.—*A.G.I.*



ELECTRON "BULLETS" in the electronic diffraction camera are being used in the laboratory to study the problems of rust and corrosion, as told on page 78 of this issue. Dr. Gulbransen, investigator who is conducting this research, is shown in our front cover illustration adjusting a gas pressure valve in the tube where the "bullets" are formed.

•

SCIENTIFIC AMERICAN

Owned and published by Munn & Company, Inc., Orson D. Munn, President; I. Sheldon Tilney, Vice-President; John P. Davis, Secretary-Treasurer; A. P. Peck, Assistant Secretary; all at 24 West 40th Street, New York, 18, N. Y.

NINETY-NINTH YEAR **ORSON D. MUNN, Editor**

Editorial Staff

ALBERT G. INGALLS — A. P. PECK — A. M. TILNEY
JOHN P. DAVIS — K. M. CANAVAN
PROFESSOR HENRY NORRIS RUSSELL — PROFESSOR ALEXANDER KLEMIN

AUGUST • 1943

SCIENTIFIC AMERICAN, August, 1943. Vol. 169, No. 2. Entered at the New York, New York, Post Office as second class matter June 28, 1879, under the act of March 3, 1879, additional entry at Orange, Connecticut. Published monthly by Munn & Co., Inc., 24 West 40th Street, New York, 18, N. Y.

Subscription rate $4.00 per year. Canada and foreign $5.00

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of August, 1893)

FIELD 'PHONE—"Some recent experiments abroad by Captain Charollois on the use of a field telephone outfit for military operations indicate that it has great possibilities as a means of communications in the field. . . The small magnetic receivers can be used as the wire is being paid out on the ground, and thus constant communication is kept with the starting point as the line progresses. . . Cavalrymen, or infantry on bicycles, could establish a line with great rapidity."

THEN CAME BUSES—"The perfection of the overhead trolley system has done a great deal to advance rapid transit and render it possible for people with small means to live in the cheap and generally attractive suburbs. . . It is only a question of a few years when the whole State of New Jersey will be gridironed with trolley roads."

ELECTRIC LOCOMOTIVE—"The first electric locomotive of any considerable size in the United States, and what is said to be the first practically operative high speed electric locomotive in the world, adapted to the steam railroad, has recently been completed at the Lynn works of the General Electric Company, and will shortly be exhibited at the World's Fair. . . It is a 30-ton locomotive, designed for a normal speed of 30 miles an hour, primarily intended for operation on elevated railways, and for passenger and light freight traffic on less important steam roads."

OCEAN SPEED—"There are already several ships that can cross the Atlantic at an average speed of over 20 knots or 23 statute miles per hour. The Campania crossed from Sandy Hook to Queenstown, on her first voyage in May last, at an average of 21.3 knots, and during one day she averaged 22.3 knots."

TUNNEL VENTILATION—"In the important matter of ventilation, the method resorted to in the tunnel beneath the Mersey at Liverpool is claimed to present one of the most striking achievements. . . At and near the middle of the tunnel are openings to a smaller side drift or tunnel running alongside of the main tunnel to the shore end, where is fixed a large fan, the result being that air constantly enters at the stations, which are thus swept clear of all foul air."

LENSES—"The use of lenses has been traced to the Chinese moralist Confucius, 748 B.C. A glass case in the Assyrian section of the British Museum contains a piece of rock crystal formed into the shape of a plano-convex lens 1½ inches in diameter and 9/10 inch thick. This was discovered in the ruin called Nimroud. It gives a focus of 4½ inches. . . The date is about 700 B.C."

MEXICAN PROGRESS—"Among the notable industrial enterprises recently inaugurated in Mexico is the electric lighting of the City of Guadalajara. The plant utilizes the famous Juanacatlan waterfalls, which are situated about 18 miles from Guadalajara. The Thomson-Houston generators are actuated by Leffel turbines, the head of water being 58 feet. Three turbines of 550 horse power are used. The dynamos for arc lighting have a capacity each for 50 arc lights of 2,000 candle power."

INCANDESCENTS—"A number of suits have within the past few years been brought by the owners of the Edison electric light patents against opposition companies, to enjoin the manufacture and use of incandescent electric lamps. Recently several decisions have been given by the courts, in which the general consensus . . . was in favor of the Edison patent."

MACHINE GUN—"The long and close competition between rival machine guns has resulted in favor of the Maxim. It has been decided that hereafter, in the offensive equipment of British war vessels, the Maxim gun shall take the place of the five-barrel Nordenfelt and Gardner guns."

RIVER TRAVEL—"The Mississippi River has 600 affluents whose courses are marked upon the map, and a drainage area of 1,257,545 square miles. The traveler embarking upon a steamboat can sail from Pittsburgh, 4,300 miles, to Fort Benton, Mont., and from Minneapolis, 2,200 miles, to Port Eads, on the Gulf of Mexico."

CANAL BRIDGE—"The Manchester Ship Canal was constructed to enable sea-going vessels to reach Manchester, and thus avoid expensive railway transfers of freight at Liverpool. . . . The most important problem connected with the scheme,

next to the cutting of the canal itself, was the providing for the traffic which exists between the two sides of the river Mersey and the Irwell. Four roads cross the canal, one at Barton, one at Warburton, and two at Warrington. In addition to the road bridges, the Bridgewater Canal and five railroad bridges, as well as the famous Runcorn Viaduct, cross the canal. In the final plans, swing bridges were abandoned and high level bridges were substituted. The Warburton Road bridge [illustrated] was designed by Mr. E. Leader Williams, M. Inst. C.E., and is a fine example of a cantilever bridge."

BULLETS—"Experiments made at the Frankford arsenal demonstrate that a nickel-steel covered, unlubricated cartridge is better than the old copper case with lubricated bullet. The velocity of the new 220-grain bullet of 30-caliber is 2,000 feet per second, while the velocity of a 45-caliber, 500-grain bullet is only 1,300 feet. . . . A small caliber bullet of the new type fired at oak timbers placed lengthwise, penetrates 30 inches at 30-yards range, while the present bullet will penetrate only 4 to 5 inches at the same range. Accuracy . . . with the new bullet . . . is remarkable."

PATENT SPEED-UP—"The new Commissioner of Patents, the Hon. John S. Seymour, deserves praise for his recent efforts to bring up to date the work now pending in the United States Patent Office."

"Quotes . . ."

"Don't expect manufacturers to be turning out 'dream models' of the ultra-modern household appliances you may have seen pictured, as soon as the war is over. Eventually, we will be having domestic peace-time appliances such as had not even been thought of before the war, but not immediately." R. C. Cosgrove, Vice President, The Crosley Corporation.

• •

"It is probable that many types of military aircraft could be converted to inefficient commercial usage. . . . But, despite the appearance of immediate saving in initial cost, the attempt to utilize converted military aircraft on any appreciable scale in this country or on our principal world trade routes would be a gross mistake." Colonel Edgar S. Gorrell, President, Air Transport Association of America.

• •

"We have been urging our people on the B & O to think of their railroad as a war production industry in the first rank—and of themselves as war workers. . . . We have asked them to exercise care, to work safely to avoid injury to themselves and to others and we ask the older employees to assist the new and the inexperienced." Roy B. White, President, Baltimore and Ohio Railroad Company.

• •

"I think the time for merely speculative post-war planning has passed. The time for designing is here. Our primary present task is to attend to the preliminaries—the legal and financial phases of public construction, the acquisition of sites and the advance of engineering—so employment will be immediately available when the war ends." Major General Philip B. Fleming, Federal Works Agency.

• •

"The need for more and better highways and what we term farm-to-market roads is recognized as vital and essential to the continuing progress and growth of our nation. . . . A road-building program, if carried out under the contract system, will in no way detract from or hinder private enterprise." Arkansas Senator John L. McClellan.

• •

"The public in general seems to believe that we have many new implements of destruction and defense. But have we? Are not the ships, submarines, guns, planes, tanks, and ammunition used in this war the same as those we used in the last great war, except for improvements in design and effectiveness? Our only new weapon is radionics!" Commander E. F. McDonald, Jr., President, Zenith Radio Corporation.

• •

"Whenever an important discovery or invention is made it has usually been foreseen for 10 or 15 years. This can be proven by a number of instances out of the development of radio. One of these proofs was given a couple of weeks ago by an announcement of Radar made by the Army and the Navy." Dr. E. F. W. Alexanderson, Consulting Engineer, General Electric Company.

99TH YEAR SCIENTIFIC AMERICAN AUGUST 1943

INVASION COMMUNICATIONS

The Jobs of the Signal Corps are Many and Varied

RICHARD L. SIGERSON

MILITARY security prevents revelation of detailed facts concerning the Signal Corps role in invasion of a specific country or area. The following article, based on North African and other operations, therefore represents a composite story with facts taken from a number of Signal Corps operations ascribed to the African invasion in order to portray fully the functions of the Corps without revealing information which would be of value to the enemy.—*The Editor.*

THE GROUP of soldiers moving silently shoreward in the steel-armored invasion launch hours before dawn were tense, absorbed in the thoughts of men enroute to a rendezvous with violence.

Perhaps through the thoughts of some ran the phrase that is both code and slogan in the United States Army Signal Corps: "The difficult we do at once; the impossible may take a little longer." The "difficult" now was to precede an army of Allied soldiers in the invasion of an important North African city. They were to establish and hold communication beach-heads that would complete the nervous system for directing, coördinating, and controlling the invading assault troops scheduled to land in exactly seven hours.

The invasion barge bumped against the sandy beach. Its powerful marine motor, the muffled underwater exhaust burbling softly, continued to drive the screw, holding the blunt prow of the craft firmly aground. Several Signal Corps men leaped into the water and struggled through knee-deep surf to dry land where they spread out to scout the beach and act as sentries. The remainder of the crew swiftly unloaded the barge of its cargo of wooden chests and reels of telephone wire.

For weeks these picked men had studied detail maps of the coastline; while aboard the transport they had rehearsed tirelessly each phase of the work to be done in the next few hours. Now, working in twos and fours, they picked chests and reels out of the small mound of equipment put ashore from the invasion boat, carrying some deeper inland and others along the beach to the right and left. A sergeant and an enlisted technician seized a particular chest from the pile and started inland. The maps listed a small knoll rising up from the beach in this direction, several hundred yards from the shore line. As they approached this point a low voice hailed them. It was one of the Signal Corps scouts.

He led them to a spot he had already picked out. Unslinging shovels, they quickly dug a niche in the embankment large enough to conceal a field telephone switchboard and its operator. The lid of the chest was swung back, a stunted switchboard lifted out and set into place. While the erstwhile sentry removed other articles from the chest, including a 12-pound leather encased portable field telephone, a kit of repair and wire-splicing tools, tape, and wire connectors, the sergeant and private trotted back for more equipment. Presently they returned with a reel of rubber covered telephone wire. Wire ends were connected to the switchboard, a carrying rod inserted through the center of the reel and they trotted off again, stringing wire from the spinning reel toward the harbor.

WHILE these men were setting up the first field switchboards, others were busy in other directions. Some dug foxholes that would later be used for advance observation and gunnery posts, while some strung telephone wire along the ground leading to these foxholes. Still others ran lines far down the beach, working stealthily to avoid prematurely alarming the defending forces. Portable radio transmitters and receivers were set up to complete the semi-circular communications network that extended from the projected spearhead of the attack at the central landing point to embrace outlying flanks on either side. At one point, Signal Corps men stumbled upon a stone building where 75 sleeping enemy troops were quartered. They quietly entered the building, disarmed the men and took them prisoner. A guard was mounted over the captured soldiers who moved them into a nearby railway building, their original quarters being later turned into a Signal Corps message center. The contingency of encountering enemy forces was neither welcome nor unexpected. But it was a contingency that would not be permitted to interfere with setting up, within the alloted time, a communications system by which the main body of assault troops and armored units could be controlled and directed when the battle began.


Tank communication by radio 'phone

As day broke a few hours later, the air screamed with the cataclysmic sounds of bursting shells and heavy cannon, which momentarily receded only to well up again in greater volume when giant ship rifles found the range of new targets. During these lulls the coughing grunts of tanks furrowing tracks across the sandy beach and nosing their way into barricaded city streets mingled with the staccato of machine guns and the sharper spat of infantry light arms. The Signal Corps had fulfilled its initial assignment and the struggle for the African city was on.

These were the noises all present heard. But the air was crowded with other sounds: The shrill notes of radio code and the cryptic clearness of military orders broadcast over close-talking, specially-designed microphones of the Signal Corps. Hundreds of radios, in as many jeeps, tanks, reconnaissance cars, fighter

planes, bombers, and big-bellied transports, loaded with paratroopers, spilled their messages into the tumultuous morning air. Submarines on underwater patrol along the perimeter of the invasion armada added to the radio hubbub. The import of these messages, plus those carried over telephone lines, was translated by message centers, sorted, and sent along to the final destination. That destination might be the commanding general's field headquarters, or a concealed one-man observation post in a section yet to be won from the enemy.

If communications lines make up the nervous system of an army, the message center is the brain controlling the impulses of that nervous system. It is at the message center that all messages, orders, and progress reports between the field and operational headquarters are picked up and relayed to the proper recipient. It is here that priorities and routes are assigned to incoming and outgoing messages. Security and speed of transmission are the two primary considerations. A message center chief, perhaps an enlisted man, may hold up an important order from the commanding officer while clearing telephone lines to handle the message, instead of sending it immediately by radio. Radio transmission is usually rapid, but from the viewpoint of military security, it is less safe then telephony. Enemy monitors may sit behind their own lines and tap any available radio frequency, but to tap telephone wires they must locate the conductors and then tie in their own listening apparatus.

To avoid overcrowding and confusion on the available wave bands of the radio spectrum, Signal Corps radios are operated on so-called "nets." Assume an attacking Allied force composed of tanks and armored units, artillery, motorized infantry, anti-tank and anti-aircraft batteries, and a squadron of interceptor planes. The radios in one or more of these combat groups would be set on a predetermined frequency, achieving an effect akin to that of a party-line telephone service. There you have a radio net. Unlike the party-line service, radio nets afford facilities for two or more communications simultaneously. A simple illustration of this may be found on a standard home radio receiver by tuning in a station carrying a news broadcast with a background of Morse code. Both are clearly audible to the listener.

In Africa, as in all military land operations, communications lines were geared to keep pace with all units of the Army, and advance observation posts established far out ahead of the foremost troops. As the Allied army threw its armored net around and drove steel columns into the city, the Signal Corps advanced its control network of communications lines, assigned more radio nets as additional forces left the transports to participate in taking the city. Complete radio and telephone message centers, mounted on trucks and manned by trained operators, also came ashore to aid in keeping all units of the indriving Army fluid and immediately responsive to changes in tactics made necessary by the changing tactics of the defenders.

An example of the role of the Signal Corps may be seen from the following messages:

"Post 9 reporting. We are being held up. Enemy forces are strongly entrenched in three concrete buildings fronting our positions. Our firepower is too weak to penetrate their defenses. . . ."

The message is received at field headquarters. Two minutes later a carrier-based observation plane appears and circles above Post 9. In the forward gun turret of a destroyer lying off the harbor, a message from the fire control bridge comes over the gunnery officer's earphones. "Cease firing," he orders. A moment later the range of the new target reaches fire control from the plane, is relayed to the gunnery officer. The forward turret swings five degrees to starboard, the rifles dip a fractional measurement and resume firing. Five minutes later there is a minute change in range, the guns are now pounding the second building of the three that have been holding up Post 9's progress. They then shift to the third building. Meanwhile, the commander of a corps of General Grant tanks is ordered to dispatch a tank to Post 9 to lead an infantry attack on the three buildings when the shelling is finished. Post 10, at the left of Post 9, has been encountering little opposition, is driving in too fast and exposing its flanks. Headquarters orders the 2nd Lieutenant in command to detail a machine-gun crew and 50 men to the aid of Post 9. Post 10 will then dig in and hold until Post 9 can move forward.

Eighteen minutes later Post 9 has cleaned out and is occupying the three buildings, the observation plane is hovering over another part of the city, the destroyer's guns are firing at a target far off on the right flank, and the tank is returning to its corps.

Peep and trailer lay a jungle 'phone line

Throughout the day over the entire battle area, similar incidents are repeated and multiplied. Ammunition is rushed from a transport to a howitzer battery. Wounded men are carried to a protected area in the central harbor docks where an invasion barge is waiting to carry them to dressing stations aboard a battleship. A field kitchen grinds off a landing boat with hot soup and food for 600 hungry men in the central sector. The battle is going well. All the Army's parts are operating smoothly and efficiently, due in no small part to the efficiency of the communications system.

Two tested wheel-horses of the Signal Corps are the teletypewriter, which operates over telephone wires, and the photo-electric radio transmitter. In the case of the teletypewriter, an operator sits at a keyboard only slightly different from that of a typewriter. As he types, a narrow paper tape feeds through a perforating attachment which punches tiny holes in the tape. When the message is ready to send, the tape is merely fed into a transmitter and impulses are transmitted along telephone wires to other printers which duplicate the perforations in the original tape, or type out the message on rolls of paper, as desired. If required, an operator may send by "direct keyboard." In this the tape is not used, but electrical impulses set up when the operator strikes the letter keys are transmitted to receiving machines, causing these to type out the message.

With photo-electric sending, the sound pattern of a telegrapher's manually-operated "bug" is inked, rather than punched, on a tape like that used in the teletype. Tapes may be prepared prior to sending by operators working at normal or subnormal speeds. When these tapes are transmitted—photo-cells picking up the inked images and translating them into electrical impulses—the sending speed may be stepped up to well over a hundred words per minute, making it impossible to distinguish individual Morse symbols by ear. Recorded by a receiver, which operates a high-speed inking device to re-establish on a paper ribbon the pattern of the original tape, the messages are automatically wound up on reels and then slowly unwound before code operators who transcribe the inked pattern into "a-b-c" characters on typewriters.

Although often mounted in mobile message center trucks, photo-electric and teletypewriter sets are used largely in primary message centers set up behind the front lines in battle areas. It was through the primary message centers that close contact was maintained between all Allied units participating in the invasion of Africa, from those attacking at Casablanca, Oran, and Algiers to the British army pursuing Rommel's Afrika Korps along the Mediterranean coast toward

Tobruk. Primary message centers also link the expeditionary forces with the General Staff in Washington, enabling it to balance the needs of one war theater against those of another, and to plan over-all strategy as well as area tactics.

Hundreds of radio stations, thousands of miles of telegraphic and telephonic submarine cable and wire are manned by the Signal Corps to bring the most far-flung tank corps, infantry battalion, or battleship within voice range of Commander-in-Chief Roosevelt at his White House desk.

THE COMPLEX, carefully-wrought Signal Corps with its tremendous responsibility to the Armed Forces has what is probably the highest concentration of specialized talent in the U. S. war machine. Not only must Signal Corps men be soldiers, they must also be able to install, operate, maintain, and, often, build the innumerable electronic and signal devices required in their service to the land forces of the Army and the Air Forces.

One of its many tasks is that of installing and operating secret equipment used in aircraft warning centers.

Military personnel are at the filter and operations boards plotting, on the basis of the reports coming in over their earphones, the course of converging enemy planes. Signal Corps linguists working in relays sit at powerful radios day and night sweeping the entire frequency spectrum to intercept military transmission of the enemy.

One classification of experts in the Corps is concerned solely with supplying the Army Ground and Service Forces with photographic personnel. With their movie and still cameras they perform a variety of important chores. In one instance this may be locating, by camera, camouflaged Axis gun emplacements which cannot be picked out by eye alone. In another, it might be the preparation of training films which are an important aid in training new men in many branches of the armed forces.

While the Signal Corps man is ubiquitous where Americans are fighting or training, he has no monopoly on the use of the instruments of his trade. Often as not the lone soldier picking his way cautiously toward enemy positions with a five pound "handie-talkie" midget radio will be an infantryman.

First ashore—a field switchboard

Most popular Signal Corps instrument in the Army in this handie-talkie. Originally designed for paratroopers, the handie-talkie is now in large demand by the infantry. Its light weight and simple operation contribute to its popularity. The 36-inch antenna collapses into the chassis, automatically turns the set on when extended; slight pressure on the grip permits two-way conversation. The handie-talkie may be easily pre-set on any one of two dozen frequencies. Operated in nets, interchangeable frequencies permit innumerable sets to be used within range of each other by different units, such as reconnaissance, artillery, and paratroopers, without jamming or causing confusion.

Similar to the handie-talkie, but weighing 26 pounds and affording a much greater sending range, the "walkie-talkie" is the next step up in portable field radios. Carried on shoulder straps like a pack, the walkie-talkie is really a grown-up radio and, when used in conjunction with a hand generator, transmits signals an impressive distance.

Handie-talkie, weight five pounds

Wire and cable, for both telephone and telegraph circuits, however, are still the bone structure of the Signal Corps. These channels provide the greatest security for confidential transmission and are least subject to enemy interference.

Signal Corps wires are now laid, usually by jeeps and trucks, at high speeds. A most interesting wire is the new rubber-covered cable called the "Spiral-4." Spiral-4, developed by Western Electric Company and Bell Telephone Laboratories, consists of four spiraling wires that accommodate three telephone and four telegraph circuits for simultaneous transmission. Manufactured in quarter-mile lengths, the ends of each are fitted with weather-proof connectors to give the desired length of unbroken cable. The new connectors speed up the laying of wires as they eliminate splicing.

The teletypewriter moves by truck

Prominent military feature of the Spiral-4 is the greater degree of security it offers. The seven telephone and telegraph messages cannot be piped directly into the cable. If this were done they would become hopelessly garbled. Instead, an electronic instrument at either end of the line first generates "carrier" currents. These currents, cousins to the familiar radio wave, retain their identity while intermingling freely in an electrical circuit. The individual messages are superimposed on the carrier currents by the terminal mechanism and ride through the cable pickaback. At the receiving end, the electronic device tosses the carrier current into the discard and guides each signal into its own pair of telephone wires.

Even if the enemy located Spiral-4 military lines and tapped them, he would get nothing for his dangerous efforts but an unintelligible mixture of squeaks and squeals in his headphones.

Mentionable duties and the apparatus for fulfilling those duties in the Signal Corps convey only a fraction of its war-time story. The "unmentionables" make up the most thrilling chapters in its current service record, a record which will be generally known and fully appreciated only after the Signal Corps has circled the globe with its network of communications lines and established primary message centers in Tokyo and Berlin.

●

PRESENT perfection of equipment used by the United States Signal Corps is a triumph of technical research, often performed under pressure of immediate demand, but likewise often with a solid background of long useage under field conditions. An example of such long useage is found in the field telephone, mentioned in the first paragraph on the "50 Years Ago. . ." page in this issue. As far back as half a century ago, the military forces were experimenting with this means of communication and were developing methods of laying telephone cables at high speed.—The Editor.

Industrial Blasting

Technological Progress Reveals New Uses for Dynamite as Well as New Dynamites that are Safe, Controllable

FRANK J. BYRNE
E. I. du Pont de Nemours and Company

After this war is over the production of industrial explosives—as differentiated from military explosives—in the United States will probably be pointed to as one of the great fundamental accomplishments responsible for the crushing superiority in battle materials which made the victory possible. The output of these explosives this year will likely reach more than 500,000,000 pounds, which is a record. They are the force behind the enormous production of coal and metals. Without them, mining could never deliver vital products in the quantities required. They add a factor of speed and efficiency in providing the materials for building roads, cantonments, air fields, and other projects.

For example: Steel, considered the index of business in this country because next to farming it is our greatest single industry, is dependent upon explosives for the production of its finished product. In the extensive pit mines of the Mesaba Range in northern Minnesota, explosives are used to loosen up the iron ore so that it can be handled by the steam shovels. In the bituminous mines of western Pennsylvania, explosives are used to break down the coal to be made into coke for the reduction of this iron ore. In the big quarries of the lower Michigan Peninsula, explosives are used to blast out solid limestone, which is subsequently crushed and shipped to the furnaces where it is used for a flux with the coke and the ore for the manufacture of iron and steel.

The ships and cars which convey these raw materials to the steel mill are moved by the energy in the coal blasted down by explosives. Not only are railroad trains and tracks, ships and engines, bridges and highways, buildings and automobiles, constructed from the metals or the stone produced by the aid of explosives, but many familiar articles of everyday life also are dependent at some stage on explosives for their economical production.

The United States normally uses more industrial explosives than all Europe combined. In an ordinary year about 350,000,000 pounds of various kinds of dynamite and 60,000,000 pounds of black powder are employed for commercial purposes in the United States, whereas only about one tenth as much is used in Great Britain.

With the country at war, and victory hanging on our efforts to turn out metals for the tanks, cannon, bombs, airplanes, ships, guns of all kinds, and other implements of battle, it is a matter of supreme importance that there be no shortage of industrial explosives. Some idea of what is being accomplished with them can be had by a reference to the production of the great iron ranges in the Middle West, mentioned above. In a year of normal business, 55,000,000 tons of iron ore are produced in the United States. In 1929, 67,000,000 tons were produced in the ranges of Michigan and Minnesota. In 1942, the total was 91,000,000 tons. It is expected that 97,000,000 tons will be taken out of those ranges this year. An important point in connection with this is that less explosives were required to mine the 91,000,000 tons in 1942 than to mine the 67,000,000 tons in 1929. This was due not only to improved earth-moving machinery and changes in overburden, but also to more efficient explosives made possible by technological advances.

Dynamite blasts a new channel for a stream

And in coal, explosives experts expect to see more than 660,000,000 tons mined as against the 400,000,000 tons in a normal year.

Construction work has always employed important quantities of industrial explosives. The building of Boulder Dam required more than 10,000,000 pounds of dynamite. Not long ago, the construction of a water tunnel for New York City used 25,000,000 pounds. Canals, highways, tunnels, and railroads employ large amounts. In building new concrete roads, approximately 1000 pounds of dynamite are employed for each mile in clearing the right-of-way and in supplying stone and cement.

Explosives experts have always used dynamite for operations where no other agent could be so quickly or efficiently applied. Ice jams threatening towns and water works have been broken, ditches have been dug in the South where it was impossible to employ any other product because the right-of-way ran through swamps where logs, stumps, and other debris formed obstacles too great for mechanical shovels. In those cases, the explosives man crawling through the underbrush has put down dynamite cartridges a certain distance apart and blasted out a ditch with one shot, sending the logs, rock, stumps and other impediments flying into the air.

This "pinch hitting" is being done now also to help along the war effort. Recently, at a strategic airport, it was found that the great landing field was likely to be menaced by floods. Explosives experts used dynamite to blast what is known as a rim canal, 40 feet wide and eight feet deep, all around the field. Lateral ditches were also blasted so that the running water could be carried away. Today, at a saving of many man-hours and hand work, the landing field is able to operate efficiently. In this job, 350,000 pounds of dynamite were employed.

In another case, a landing area for a seaplane base was vitally needed on one of the coasts. Dredges could not get out the rock. Dynamite experts drilled hundreds of holes, brought into play their knowledge of underwater blasting and in a short time had cleared the bottom.

Because of the need of improving navigation for heavy ocean going ships, harbors are being deepened, reefs and obstructions blasted out, and adequate channels being constructed. On one of these jobs alone, 500,000 pounds of dynamite are being employed.

In one of the western states, the army wished to demolish a bridge over a river. The explosives experts placed small

charges all throughout the structure and detonated them at one time. The great bridge fell as if cut with a giant knife.

The speed with which the "Big Inch" can be laid depends in large part on explosives. Something like 750,000 pounds of dynamite are being used to loosen up the right-of-way and lay this, the longest and largest pipe line ever constructed, from a point in the Midwest to its Eastern terminus. This large pipe line is crossing 13 rivers. It will go over mountain ranges and through valleys. It is estimated that about 1000 pounds of explosives will be used for every mile where the rock and stone prevent shovels from scooping out the earth.

A highly interesting part of the job is laying the pipe line across rivers. Explosives experts are blasting trenches in the bottoms of those rivers. This is one of the time-saving and expert techniques developed by explosives specialists. With the help of boats, barges, drills, dredges and other paraphernalia, holes are drilled in the right-of-way across the stream. Gelatin dynamite which works efficiently under water is loaded into the holes. The equipment is moved out of the way when everything is ready, and the blast fired. The pipe is ready to be lowered as soon as the curtain of water and the debris which has been hurled into the air have dropped. Section by section, the river is thus crossed in a fraction of the time possible by any other method.

Industrial explosives and military explosives are entirely different materials, although often they are confused in the layman's mind. Military explosives are mainly propellants, such as smokeless powder, and disruptives such as TNT for shell bursting charges, mines, and bombs. Industrial explosives include dynamite and blasting powder, neither of prime importance for military purposes as such.

Black powder is not used as a propellant in modern warfare, as the smoke produced on firing would disclose the location of the gun. Dynamite cannot be used as a propellant as its speed of detonation is so great that it would shatter the gun. It cannot be used as a bursting charge in shells as the shock of shooting the shell from the gun would also set off the bursting charge and wreck the gun. On the other hand, military explosives such as smokeless powder and TNT are not adapted for use in mines and quarries.

Not only is it impossible to use dynamite as a propellant or for shell-bursting charges, but dynamite manufacturing plants cannot be converted into smokeless powder plants in time of war. The only ingredients common to both are nitric and sulfuric acid. The dynamite manufacturing apparatus is entirely different, the processes and chemical composition totally unlike that of military explosives, and it takes a considerable period of time to train the personnel of both dynamite and smokeless powder plants in their specialties.

Organized research in dynamite has been going on for more than 40 years. Workers have studied the needs of the various consuming industries and as a result have provided a multiplicity of types

Nitramon blasts out limestone in a quarry

and grades to satisfy them. They have developed methods for measuring the power of an explosive; methods for determining quickly and accurately its shattering and pulverizing power, its water resistance, its safety characteristics when exposed to shock and flame, the composition of the gases produced on explosion, and other phenomena.

With the methods developed, as a result of prolonged study of the influence of various factors on the properties of dynamite, it has become possible on short notice to design a dynamite combining the qualities best suited for practically any blasting or mining condition.

Many problems have been solved and great progress has been made as the result of this research work. One serious problem that confronted the explosives industry in the early days was that of frozen dynamite. Nitroglycerin, the liquid ingredient of most dynamites, has a relatively high freezing point, around 52 degrees, Fahrenheit. Since many blasters have to work in wintry weather at temperatures far below that freezing point, it was not uncommon for them to encounter frozen dynamite, which was not only unsatisfactory, but also hazardous to use. It could be thawed safely by careful, trained workers, but the miners and quarrymen often used short-cut methods, with fatal consequences.

How to solve this problem was not an easy task, although it was known that the freezing points of liquids could be lowered by dissolving other materials in them. The chief difficulty was in finding a compound that could be added in a relatively high percentage without seriously affecting other essential properties of the dynamite, particularly its propagating power at low temperatures. Research and experimental work were carried on for a number of years, and many diverse freezing-point depressants, such as TNT, nitrated sugars, and nitrated polymerized glycerin, were used with some success. Although reasonably satisfactory low-freezing dynamites were developed in the laboratory as early as 1912, the most satisfactory solution of the problem came in 1925 with the use of ethylene glycol dinitrate as an anti-freeze. This material is not added to nitroglycerin, but when a mixture of ethylene glycol and glycerin is nitrated, the resulting product has a very low freezing point. Frozen dynamites have thus ceased to be a problem to explosives users even in locations where temperatures range as low as 40 to 50 degrees below zero. Anti-freeze protection for dynamite—and for automobile radiators, too—is achieved with ethylene glycol, although it is applied in different ways. The two innovations came practically in the same year.

Next to nitroglycerine, the most important explosive ingredient of dynamite is ammonium nitrate. Certain types of dynamite—many of them used in coal mining—contain up to 80 percent of this ingredient. It was discovered that, by varying the size of the grains of ammonium nitrate, the velocity of detonation can be controlled. In other words, by using fine particles, very fast explosives of high shattering power are obtained; conversely, by using coarse grains, the dynamite is much slower and of low shattering power. This was a discovery of great practical significance, since it allowed the production of low-velocity permissibles to bring down coal in large lumps, and high-velocity dynamites for use in hard rock where fine fragmentation was desired.

During the period under review, nitroglycerin has declined in importance as an ingredient of dynamites. It has gradually been replaced by ammonium nitrate, even though, on a weight-for-weight basis, the replacement material has only about 70 percent of the blasting energy of nitroglycerin. But ammonium nitrate is less expensive and much less sensitive. Its use has made possible dynamites that are less

Illustrations courtesy Du Pont Company

Dynamite offers economy in demolishing buildings, stacks, and so on

hazardous to manufacture, handle, and use; moreover, consumers have the benefit of lower cost per unit of energy.

Research development reached a new high point in 1935 with the introduction of "Nitramon" blasting agent, which contains a high percentage of ammonium nitrate; no ingredient of this product is explosive by itself. "Nitramon" is insensitive to the action of a commercial blasting cap, to shock, friction, or the impact of a rifle bullet. To explode it one must employ a booster charge of a more sensitive material. Actually, it is the safest blasting agent available, although it is equal in strength to the most powerful dynamites. It is particularly suited for use in large-scale quarry operations, and a special type, "Nitramon" S, has been introduced successfully for seismic exploration work.

Another problem of long standing concerns the manufacture of dynamites that will produce a minimum of noxious fumes on explosion. The explosive power of dynamites comes from their almost instantaneous expansion from a solid mass to a very large volume of gases, conceivably a ten-thousand-fold expansion. When charges of dynamite are exploded in confined spaces underground, as in mines or tunnels, it is important that the fumes resulting from the blast shall be as free as possible from poisonous effects on the men as they return to the working faces.

The major portions of dynamite compositions consist of carbon, nitrogen, and oxygen-containing compounds in properly-balanced proportions. Years of research were spent in the laboratory and in mines and tunnels before properly-balanced explosives for underground use were designed and produced commercially. But the results are exemplified by the fact that improved dynamites are being used to drive big-bore tunnels through which water flows from far-distant reservoirs to supply the vital needs of our large cities. It would have been impractical and unduly hazardous to construct such tunnels, if chemical research had not made possible more suitable dynamites for the purpose.

This research work, in addition to the extraordinary manufacturing skill displayed and the wide-flung activities of technical men in the field, examining every possible practical application of industrial explosives, has developed a body of specialists who are today doing the biggest job of their career. Despite huge war demands, explosives in the quantities required are ready for the job. There is no shortage of these vital materials. Moreover, they are being forwarded to users with practically no delay and with the minimum use of priorities.

• • •

VEST-POCKET AUTOMOBILES

Future Cars to be Small and Light

Post-war automobiles will be small, light-weight editions fueled by high-octane, heavily-taxed gasolines now available only for military aircraft and motorized equipment. Post-war manufacture of 100-plus octane gasolines will force engineers to design Diesel engines which will get the utmost out of low-cetane fuels for railroad, marine, long-distance and air cargo, and construction service.

These predictions for the post-war petroleum fuels situation were recently placed before the Diesel Engine and Fuels and Lubricants Meeting of the Society of Automotive Engineers by Dr. C. M. Larson, chief consulting engineer, Sinclair Refining Company. He reported that high-octane aviation gasolines, explosives, synthetic rubbers, plastics, anesthetics, and other essential war products now are being made in petroleum refineries at the expense of the kerosenes and distillates from which Diesel fuels are derived. He expressed the opinion that Diesel fuels will be on the critical list by 1944 and said that even after the war the extremes between octanes for gasoline engines and cetanes for Diesel engines will broaden in favor of high octanes to the detriment of Diesel fuel ignition quality.

Dr. Larson's post-war picture indicated that premium grade gasolines will be 87- to 90-octane, regular grades 80-octane, and third grades 72- to 75-octane. Tractor or distillate fuels of 50-octane, 40-cetane, will be available, but in many regions tractor distillate fuels will have to be used with 37-40 cetane, or cetane additive agents will be employed to maintain the 50-cetane minimum called for by manufacturers of high-speed Diesel engines.

He warned that the current demand for distillate fuels by the armed forces, particularly the Navy, will reduce the potential of Diesel fuels and heating oils. He estimated the 1945 production ratio of gasoline to distillate fuel at seven to one as compared with three to one at the start of World War II.

GLUE "WELDING"

Spots are Quickly Set By Radio-Thermics

Ingenious as modern lumber cutting methods are, no one has yet devised a way to square off a round log without getting a lot of miscellaneous narrow waste stock in the cut. At the present time particularly, when great quantities of logs are being cut for structural framing to replace steel, and increasingly smaller logs are being cut for ordinary lumber purposes, there is a tremendous amount of narrow stock piling up in lumber yards, and the need for an outlet for this material is rapidly becoming acute.

Even before the present emergency, however, this surplus of narrow boards was a special headache to both lumber manufacturers and timber conservationists. Extensive research has been carried on over a period of many years in efforts to find commercial uses for this narrow material.

The most successful development so far—that of gluing narrow lumber together to make wider usable stocks—has been for the most part a slow and uneconomic procedure complicated by hand methods or by expensive and involved machinery.

Now, however, industrial glue research offers a solution that may prove revolutionary. A new gluing process has been developed by I. F. Laucks, Inc., manufacturing chemists, by which boards are joined together edge to edge by means of "spot welding" or the setting of the glue only in spots along the joint. This method employs momentary pressure and eliminates clamping and also does away with the expensive necessity of heating the whole glue line in order to set it. The welded "spots," which are spaced

about 18 inches apart, hold the boards rigidly together until the glue lines in between are also set. This general setting of the glue takes place after the boards are stacked, thereby cutting down the time the boards must be in the gluing machine.

The present apparatus uses high-frequency radio waves to set the spots. However, the efficiency of the process is not impaired by the use of other heat sources. The glue used is of a special cold-setting type and is particularly amenable to quick setting when heat application by means of the high-frequency method is employed.

Due to the urgent demand for radio and electro-thermal equipment, the availability of this high-frequency equipment is limited by approval of the priority division of the WPB, dependent upon its use.

SANDLESS GLASS

New Optical Glass Omits the Familiar Silica

A RADICALLY new type of optical glass whose unique light-bending propertie will make superior lenses for seeing, taking pictures, and studying microbes, has been developed after ten years of research, according to Dr. E. D. Tillyer, research director of the American Optical Company.

The new glass is further revolutionary because it contains no sand as an ingred-

Tillyer (right) and Moulton—glass

ient. Omission of the sand is primarily responsible for the exceptional optical properties.

By varying the composition, two glasses of the same type but having different properties have been discovered. Laboratory developments, they will not be available for some time to come.

Dr. Tillyer revealed that one of the new sandless glasses is made of several common, available chemicals—the first time this has been done successfully. These chemicals are boric acid, zinc oxide, and aluminum hydroxide or beryllium oxide.

The second sandless glass is made by substituting cadmium oxide for the zinc oxide. Dr. Tillyer disclosed that never before has the chemical element cadmium been used as a major ingredient in glass.

In comparison with previous glasses containing sand, the new ones have a much higher index of refraction, or light-bending power, and a lower dispersion, or separation of light into its different colored rays due to their different refractive capabilities.

Because of their composition, the new glasses compress the spectrum. As a result, there is relatively little difference in the light-bending power for light of different colors, and color effects, often noticeable in previous glasses containing sand and lead, are eliminated.

Other properties of the new glasses include low melting point, freedom from color, and stability to weathering and corrosion. The new compositions produce beautiful sparkling glasses which are resistant to chemical attack and almost good enough to be cut into gems.

A basic study in glass technology, the new stabilized glass containing the zinc oxide was developed by Dr. Tillyer, H. R. Moulton, and T. M. Gunn, and the one with the cadium oxide was invented by Mr. Moulton. These glasses will be used in lenses for spectacles, comeras, and scientific instruments.

BALL POWDER

Smokeless Propellant Now Made Under Water

AXIS soldiers won't ask for a second helping of the "black caviar" now in quantity production at a famous ammunition plant in Illinois. The "caviar" is ball powder, a smokeless gunpowder in the shape of minute spherical pellets made by a new process five times faster than those formerly used, according to an announcement by John M. Olin of the Western Cartridge Company.

Ball powder, Mr Olin points out, is manufactured chemically under water by a patented technique which reduces to a minimum the hazard in the making of smokeless powder Although experimental lots of ball powder were manufactured by the Western Cartridge Company several years ago, its existence has been one of the ammunition industry's most closely guarded trade secrets. Unknown to them, many American peacetime shooters have been using ball powder in Western shot shells and other ammunition for some time past.

When America began its rearmament program, Western Cartridge immediately offered its ball powder patents to the War Department, which authorized the Company to use the new process in all ammunition for which it is suitable. Since then, ammunition loaded with ball powder has been widely used by the Allied troops.

Where the manufacture of ordinary smokeless powder requires fifteen days, ball powder is being produced in quantity in only three days. Where other powder is handled dry in large quantities, ball powder is manufactured in ten times its bulk in water, and when it is finished, is handled dry in small quantities only a fraction of the usual time.

The base of smokeless powder is nitrocellulose, which is made by soaking cotton or wood fibers in nitric and sulfuric acids. Until the invention of ball powder, smokeless powder was handled dry during many of its manufacturing processes, and was reduced to pellets mechanically, by forcing the nitrocellulose "dough" through a "macaroni" machine and chopping the strands into grains of the desired sizes.

In the manufacture of ball powder, nitrocellulose is produced in the conventional way. While immersed in ten times its bulk in water, the nitrocellulose is re-

Coating ball powder for easy flow

duced to a pure liquid form by various chemicals, including ethyl acetate, a substance used in women's nail polish.

By stirring the mixture, the nitrocellulose lacquer acts in water very much as olive oil does in vinegar, and forms into globules—the tiny ball powder pellets Other chemicals are added to the mixture to prevent the balls from reuniting with each other when the stirring is stopped. By controlling the speed of stirring, the powder balls can be made in a great variety of sizes suitable for a wide range of ammunition sizes.

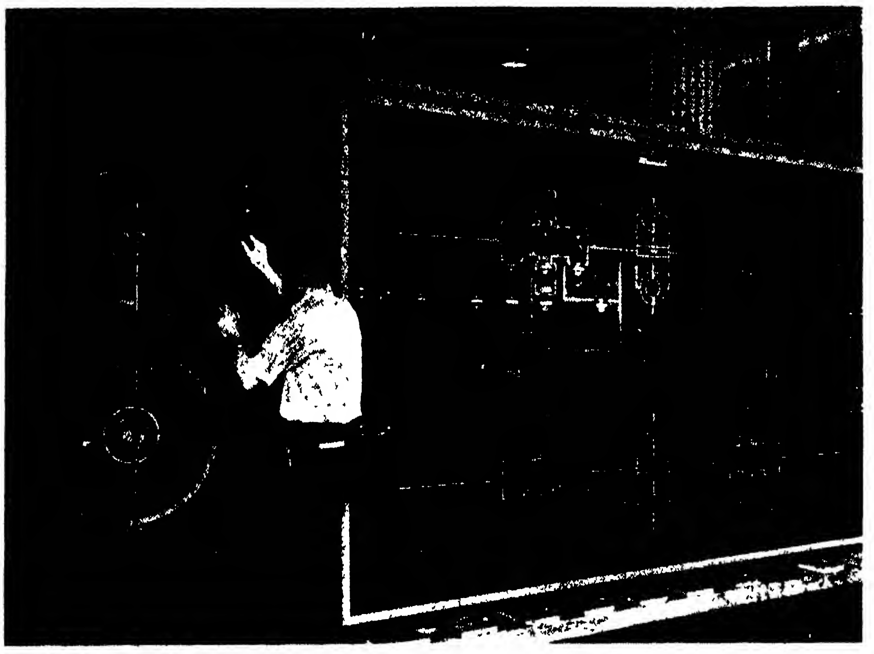
"ROBOT" CONTROL

Opens and Closes Valves Quickly, Automatically

A "ROBOT" which opens and closes dozens of valves with split-second timing now controls processing in many of the nation's plants producing aviation gasoline, butadiene for synthetic rubber, and toluene for explosives, according to B. M. Mills, of the petroleum and chemical section of General Electric's industrial engineering department

In such plants steam, air, and hot gases flow intermittently through a complex system of piping and tanks. These gases must follow each other at predetermined intervals, and any error in timing or route of flow would slow up production not only through loss of materials but through possible damage to equipment.

The "robot" control performs the same functions in some parts of gasoline, butadiene. and toluene plants as dispatchers and switchmen do in a railroad system. In many of these plants, even if the required numbers of skilled operators were



Testing the operator's section of a typical industrial "robot" control

available, it would be humanly impossible for them to open and close the numerous valves with the precise timing provided by the "robot" control, consisting of automatic cycle-timers and valve control.

The "robot" controls the flow with machine-like precision, minimizing the possibility of human error. If something goes wrong, such as a valve sticking open or shut, the control even voices a warning —it summons an operator by blowing a horn, or ringing a bell

Before the war this type of equipment was developed principally to produce high-octane gasoline for planes and cars. Because the same methods may be used in producing butadiene and toluene, the robot is now widely used in these two types of plants as well. Plans for extension to other types of plants requiring precise timing or valve control are under way

READERS desiring further information on new products, or research and development work reported in these pages, will be referred to manufacturers or additional sources upon request. Address our Research Department, giving specific references, incluing date of issue and page number.— *The Editor*

CHEMURGIC RUBBER
Can Be Used Alone Or As Extender

A NEW type chemurgic rubber, developed from vegetable oils, is already being used by rubber-goods manufacturers for many essential applications.

This rubberlike material, called Witcogum, is comparable to rubber in many of its properties and requires neither critical materials nor critical equipment for its manufacture. Standard rubber mills and mixers do its milling and mixing. Calendering, extrusion, and vulcanizing are similar to that of rubber.

Witcogum contains an accelerator of the guanidine type and sufficient sulfur to give a cure in 30 minutes at 40 pounds steam pressure (287 degrees, Fahrenheit). Furthermore, all the necessary vulcanizing ingredients are already in the chemurgic rubber.

Used independently or as an extender blended with natural rubber, reclaim, or synthetic rubber, the proper compounding of Witcogum with such pigments as carbon black or clay or a combination of both will result in higher tensile strength Tests have proved that tensile as high as 450 pounds per square inch, elongation as high as 150 percent, and tear of 45-50 pounds per inch can be obtained.

Water, alcohol, and lubricating oils have no apparent effect on this newest synthetic rubber, nor do antioxidants upon accelerated aging tests Generally speaking, its reactions to solvents and chemicals are similar to that of rubber.

Manufacturers have found many uses for Witcogum, thus alleviating the pressure on the small reserve of natural, reclaimed, and synthetic rubber. It is going into hose and tubing, wire insulation and gaskets, shims, brake linings and foot comfort pads, hospital sheeting, jar rings, and extruded channels, to mention only a few of its applications.

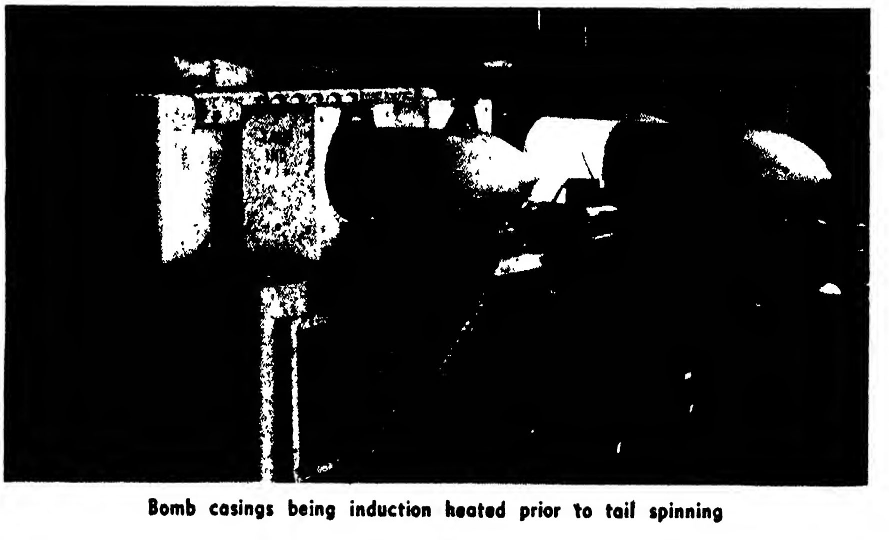
BOMB CASINGS
Made Faster With Induction Heating

COMBINATION of an automatically controlled spinner and induction heating now is enabling the Wheeling Steel Corporation to shape large one-piece 250 and 500 pound high-explosive bomb casings in just two operations. This is in contrast to other methods which require upwards of ten steps with reheats before the final shape of the bomb is achieved.

In a battery of 200 kilowatt, 3000 cycle induction machines equipped with inductors designed for this vital ordnance work by The Ohio Crankshaft Company, the casings that have been cut from heavy steel pipe are heated first for the shaping of the nose and then for the tail. Spinning follows each heating Elapsed time for these two operations on the 500 pound bomb does not exceed 14 minutes, while the smaller bomb is finished considerably faster.

Automatic control of the spinning has proved highly successful in speeding the shaping process, and induction heat has been a large factor in achieving this result. Because the Tocco machines could be placed close to the spinners it was possible to establish production-line procedure. Casings are manually withdrawn from the large multiturn inductor coils onto a roller conveyor which slides the heated pipe to the spinner.

After nosing, the casing is lifted to a gravity conveyor, down which it passes to the next unit for tailing operations En route the pipe goes through a cooling compartment. Then the tail is heated and spun into a truncated cone with open end—and a new bomb case is ready for the next operation. Because high heat is confined to the specified area on the pipe, casings can be handled by operators from inductor to spinner without tongs. Inductor coils are water cooled and have a diameter sufficient to give ½-inch clearance between metal and coil.



Bomb casings being induction heated prior to tail spinning

INDUSTRIAL TRENDS

LET THE LABORATORY DECIDE

In all fields of industrial endeavor there are today, more than ever before, demands for new ideas, new ways of doing things, new materials for new and old uses. All too often, however, these ideas die aborning, killed by the very thing that should warrant investigation—their apparent "wildness." No manufacturer can afford to throw overboard any idea that pertains directly to his business without a thorough investigation Only after an idea has been subjected to the acid test of laboratory or other expert examination can it be branded as good or bad. And even experts must occasionally be cautioned not to jump at conclusions.

Often the trend of an industry will be directly influenced by an idea that, on the surface, appears to be too hare-brained to merit consideration. Laboratory investigation, in such cases, will save the day, bringing out unforeseen facts and eliminating the "bugs" that stand in the way of success. Thus, industries that depend on new ideas for successful operation in war or peace—and what industry does not fall in this category?—will do well to let the laboratory have the final word, rather than to depend on intuition or some other unreliable "sixth sense" for final decision on new ideas.

PLYWOOD PLUS

A metal-lined plywood box for smokeless powder that is airtight and water proof, strong yet light and inexpensive, points the way to a new chapter in the intriguing story of plywood developments. Outstanding factor that made possible this box is a synthetic glue for bonding metal and plywood into a unit that resists action of water and temperature changes. From this development may well come such things as kitchen sinks and bath-tubs, industrial containers of many kinds, vats and tanks, made of a plywood base to which is cemented, in a never-to-be-parted bond, a lining of thin, light sheet metal of a type adapted to the use desired.

MANAGEMENT'S RESPONSIBILITY

Encouragement of better co-operation between employer and employee is a trend of the present, despite strikes and labor troubles that dot the daily papers. Through such co-operation management learns much, can profit if it will only take heed of the obvious.

When one large organization, as part of its co-operative operations, recently polled its employees in an effort to get a better understanding of what the employees were thinking about, they found, significantly, that the question uppermost in the employees' minds was: "Will I have a job when the war is over?"

Here is provided a basis on which to build better employee morale, to solidify worker-management good-will. Other companies would find equally interesting facts upon investigation, facts that could be readily applied to influence trends.

TURBINES FOR TRANSPORTATION

Dream of engineers for many a decade has been the elimination of reciprocating parts in prime movers. In locomotives and gasoline propelled vehicles, for example, these parts transmit power from the source to the wheels, but, because they reciprocate, they wear more rapidly and have a greater tendency to vibrate than do smoothly rotating parts. Thus it is not unlikely that the turbine, now available in refined form and being even more perfected by the requirements of certain war-time developments, will find its place in the transportation scheme of the future.

The turbine—an excellent example is found in the turbine-driven supercharger used on airplanes—derives its power from the continuous expansion of gas which is utilized to produce rotary motion directly. Turbine locomotives have been built experimentally in the past; another type is approaching the manufacturing stage now and may point the way toward new power for railroads Not unlikely, also, is development of the turbine for powering aircraft and surface vehicles, as well as a great expansion of turbine use on the oceans of the world.

TOOLS THAT MAKE TOOLS

Early in World War II the cry was for machine tools—more and more of them. So well was this demand met that, it is reported, machine-tool builders have anticipated at least ten years of their post-war markets. By doing so, however, they have learned many things about tool design and manufacture: So much, in fact, that the machine tools of tomorrow will be far more productive than the tools of yesterday and today. Through such improvements the machine-tool manufacturers will make possible better consumer goods, while at the same time recapturing markets that they have worked themselves out of by reason of manufacturing speed-up.

X-RAYS FOR INSPECTION

Standard method of inspecting many products has been, for years, the process of testing to destruction. Slow, laborious, costly, this method is, at best, not too reliable. The X-ray, however, offers a means of inspecting products ranging from rubber heels and smaller to motor-block castings and larger, and doing its job without in the least influencing or affecting the part being inspected. Not only that, but the X-ray, as now developed, can be placed right in a production line and used with a rapidity which equals that of the line itself.

Bulk of equipment was long a deterrent to the use of the X-ray in industry. Now, however, due largely to new means of insulating the power supply and to refinements in the design of the X-ray tubes themselves, the size of the necessary machinery has been reduced to a small fraction of the former requirements Such X-ray generators are doing excellent work on war production lines. They will do even more for all industry when restrictions are lifted and they can be made in quantities.

LIGNIN LOOKS LIKELY

Lignin, that part of wood which is left after the cellulose has been extracted, is a chemically stubborn stuff that is rather difficult to deal with Despite this somewhat discouraging definition, however, lignin holds promise of a bright future that may be second only to that other glamorous child of the chemist—dirty, smelly coal tar.

Combined with certain organic acids, lignin is now becoming the base of a number of compounds having a wide range of properties. Some of these compounds are hard solids, others are firm waxes, and they have an equally varying range of solubilities and melting points. Already these lignin compounds are being tested by the plastic industry, by paint manufacturers, and for possible use in the making of inks.

One good thing about lignin is its, at present, almost unlimited supply. Here is real meat for the chemical industry to sink its teeth into.

—A. P. Peck

[References to sources from which additional information may be gleaned on any of the subjects reported or predicted on this page will be gladly furnished on request to the author, addressed in care of Scientific American.]

Galactic Gas Clouds

A Complex System of Enormous Rarefied Clouds of Gas Moving at High Velocity Has Been Discovered

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate at the Mount Wilson Observatory of the Carnegie Institution of Washington

It has been known for a good while that there are a few lines in the spectra of the stars which are not produced, like the rest, by absorption in the atmospheres of the stars themselves, but arise from absorption of light by the atoms of an exceedingly tenuous gas which occupies interstellar space. These lines can usually be distinguished at a glance by their extreme sharpness and narrowness. In the relatively dense atmosphere of a star, even though it may be only a ten-thousandth part as dense as ordinary air, there are various physical causes at work which tend to widen the spectral lines. But in interstellar space, the atoms and molecules are so far apart that they are substantially undisturbed, and the inherent sharpness of these lines is more nearly (though not completely) exhibited.

Though this peculiarity helps to identify these lines, it makes it hard to observe them. Every spectroscope (like any other optical instrument) has a limited resolving power. The very properties of light waves compel the image of a sharp line to be a streak of perceptible width, fading off gradually at the edges, so that a close pair of lines can be resolved only with a powerful instrument. One might suppose, however, that this limitation would not hinder the observation of an isolated line. This is very nearly true for a bright line on a dark background. No light is lost (and of course none gained) by widening it into a streak; and, if the background is practically black, it can be seen or photographed about as well as ever.

But a narrow dark line on a bright background is quite another affair. Not only is it smeared out into a streak, but the light from each side of it is—so to speak—smeared into this streak, so that it loses contrast. With a narrow enough line, or a wide enough smearing, the remaining contrast is imperceptible, and nothing can be detected.

The stronger interstellar lines are observable with spectrographs of moderate power; but the faintest, such as those of iron, recently discovered, can be brought out only with the highest available resolving power. They can be observed, too, only in very distant stars whose light has had to traverse the interstellar gas for a thousand light-years or more. For obvious reasons, such stars do not look very bright. Hence, to get good photographs even with long exposures, the great spectroscope must be fed by a correspondingly great telescope.

Much the most powerful combination in existence is composed of the 100-inch telescope at Mount Wilson, well known to everyone, and an equally notable spectrograph which is not so familiar to the general reader. In this instrument the spectrum is produced by a diffraction grating, and focused by a concave mirror 114 inches (almost ten feet) in focal length. This mirror performs a double duty. It converts the divergent beam of light from the slit into a parallel beam falling on the grating (which works properly only for parallel light). The grating sends back parallel beams of light of different wavelengths in different directions. These fall on the same mirror, and are brought by it each to its own sharp focus on the plate. The principle of operation is very similar to that of the Schmidt camera; but the beam of light of any particular color is so narrow that the mirror alone gives a practically perfect focus, and no correcting plate is needed. The spectrograph, like the telescope, operates wholly by reflection. It is perfectly achromatic, so that the whole spectrum (from the infra-red to the ultra-violet) is in focus at once. Moreover, the light of the star reaches the plate without having to pass through any glass at all; hence the ultra-violet light is not weakened.

With this equipment, Dr. Adams has obtained hundreds of spectra of various stars, showing interstellar lines. The results, which he reported at the Astrophysical Congress in Mexico last year and has now published, are remarkable.

Dr. C. S. Beals, of the Dominion Astrophysical Observatory at Victoria, discovered seven years ago that, in a few stars, the interstellar H and K lines of calcium were close doubles. To follow up this discovery demanded greater resolving power than was then available. With the equipment just described Adams has found that in about 80 percent of the stars which he has observed these lines are complex—double or triple, and occasionally quadruple.

Typical examples are shown in the illustration (from Adams' paper). The K line is shown on the left, and the H line on the right, exhibiting practically identical patterns, which prove the reality of the phenomena. The uppermost star shows a fairly wide pair; the next a triple, with the middle component faint; the third, a close pair; the fourth, a strong line and two faint companions; the fifth shows four components on the original plates, the strongest of which run together in the cut. The wide fuzzy lines are produced in the stars' atmospheres.

There is only one explanation known to physics for such shifts of these sharp lines—namely, motion of the absorbing atoms in the line of sight. Between us and one of these stars there must be, not a continuous thin stratum of gas, but two, three, or four separate clouds of gas at different distances, each changing its distance from us at a different rate, and doubtless moving at a different speed and in a different direction in space. The sharpness of the lines suggests that most of the calcium atoms between us and the stars belong to these separate clouds, with relatively few in the empty spaces between.

The velocities of the clouds are sometimes surprisingly high. The two faint components in the lowest spectrum have shifts corresponding to velocities of 41 and 60 kilometers per second—relative to the general average of the stars near the Sun, after allowance for the solar motion. (This is a sixth magnitude star in Cygnus, No. 199478 in the Henry Draper Catalogue.)

One might expect that stars near together in the sky would be behind the same clouds, and show the same line pattern, and this often happens; for example, the stars μ and 15 Sagittarii, which are less than half a degree apart, both reveal three clouds, with volocities of 4, 22, and 40 kilometers per second (μ Sag is shown in the next line to the bottom in the illustration.) Many other examples of clouds with smaller velocities are evident in Adams' list.

In certain regions of the sky, such as Perseus and Scorpius, the lines are usually single, indicating the presence of but one cloud, while in Orion, Sagittarius, and Cygnus they are usually complex.

Fainter interstellar lines of other origin have been observed in many of these stars. By measuring their exact positions, and deriving the radial velocities, Adams finds that the atoms or molecules which produce these are usually moving with the cloud which produces the strongest calcium lines. In one star, χ Aurigae (third from the top in the illustration) which shows two calcium lines of nearly equal strength, neutral calcium, cyanogen, and neutral CH appear to belong to one cloud, and ionized CH to be present in both. This, by itself, is hardly evidence enough for differences of composition between different clouds; but Adams has obtained additional evidence that cannot be doubted. For example, the hydrocarbon lines are strong in some stars in which those of calcium are relatively weak, and absent in others where the latter are very strong.

The most recent observations with the great spectrograph include eight stars of the Pleiades. The distance of this compact cluster is known to be not far from 500 light-years. This is small from the

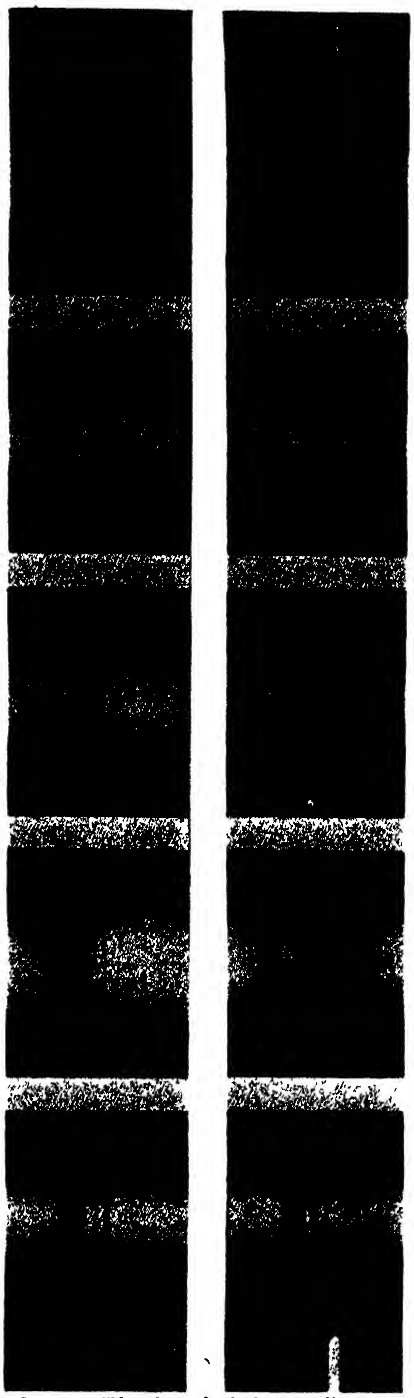
present standpoint, and the interstellar lines are faint; but the powerful instrument has revealed them in eight of the nine brightest stars of the group. The stellar lines in these spectra are very wide; the interstellar lines, in Adams' phrase, "are somewhat broad and may be complex," though separate components cannot be seen. The velocity of the interstellar cloud (or the average, if it is really complex) is 16 km/sec, receding, and nearly the same in all cases. This differs by 10 km/sec from that of the stars in the cluster, proving that the cloud has no connection with them.

So far, it looks as if we had to deal with a single cloud; but, if so, its composition is not uniform. Lines of the ionized calcium atom and the ionized hydrocarbon molecule ($CH+$) have been observed; but three of the stars show only calcium, two hydrocarbon, and three both together. As all the lines are faint this should not be taken to mean that one component or the other is entirely absent from parts of the cloud. But the relative proportions must at least be decidedly different—and this within a region of the sky only about two degrees square! This cloud beyond doubt is very patchy.

For one star in the Pleiades, Pleione, the interstellar lines cannot be observed for the reason that, a few years ago, its spectrum underwent a remarkable change. Previously, like the rest, it had shown broad hazy lines. While this spectrum persisted, an additional set of strong and much sharper lines, of hydrogen and ionized metals, appeared and still persists. The sharpness of these lines shows that they are produced in a region of much lower density than the original atmosphere; yet many lines, such as the hydrogen series, are present which we know would not be absorbed in a gas so exceedingly rarefied as are the interstellar clouds. To make a long story short, it is generally believed, on good and detailed evidence, that these lines are absorbed in a gaseous envelope a few times larger in diameter than the star itself, which was, in some way not yet fully understood, expelled from it. In Merrill's apt phrase, they are *circumstellar* lines produced close around the star, but not at its surface. The calcium lines are present in this spectrum and strong enough to swamp the interstellar lines completely.

Adams' important observations show that the interstellar gas is a far more complicated affair than was at first supposed, and is a complex system of individual clouds, rather than a roughly homogeneous medium. This ought to surprise no one, for the interstellar obscuring clouds (probably composed of fine dust) which stand out as dark markings in front of the Milky Way are exceedingly irregular both in outline and density.

In principle, one might hope that by spectral observations, upon enough stars, well scattered over the sky, the forms and limits of these gaseous clouds, as well as their motion, might be mapped. But in practice this would be exceedingly difficult. Only stars visible to the naked eye are bright enough to be observed for this purpose, even with the 100-inch telescope,



Courtesy "The Astrophysical Journal"
Complex lines (see the text)

and only the hotter stars, whose spectra are free from strong lines at the critical positions, furnish suitable backgrounds for observing the interstellar lines. The whole number of stars in the sky which satisfy both conditions is small, and they are too sparsely scattered in the heavens to permit a detailed mapping of the clouds. It is not yet certain what connection, if any, there is between the dust-clouds and gas-clouds; this is a problem for the future.

One cannot quite resist the temptation to speculate a little about these gas-clouds in space. They must be of enormous size —dozens of light-years in thickness—and are certainly of exceedingly low density.

How they got there is useless to ask, when we are still in perfect ignorance how anything else "got there"—for example, why the Galaxy and the spiral nebulae are in rotation. But there is some sense in inquiring: How can they continue to be there?—that is, as the fairly definite clouds of gas which they appear to be?

The diameters of such clouds must be relatively large in comparison to the distances between them—probably several percent of the latter. It follows that, in random motions through space, two clouds will sometimes collide. Since each of these contains enormously fewer molecules per cubic inch than the best vacuum which can be produced in the laboratory, this seems like talking about a collision between one vacuum and another.

But the word is significant, just the same. We may regard each cloud as a swarm of widely scattered molecules, pursuing practically parallel courses at substantially the same speed. When the outer boundaries of the clouds intersect, the molecules of each will proceed into the empty spaces between those of the other. So long as no collision between those of the two clouds take place, each will pass freely through the other. But each collision will send the molecules involved bouncing off in quite different directions, so that they are lost to the clouds. The fate of the clouds depends, then, upon the mean free path which a molecule is likely to travel before it collides. If this is large, compared with the sizes of the clouds, the two will pass through one another almost unaffected, and come out on the other side, leaving a small proportion of stray molecules behind dispersed by collisions. But if the size of the cloud is large, compared with the mean free path, practically all the molecules will be diverted; they will make further collisions with one another and the two clouds will be merged into one, with molecules flying so fast in all directions that they will dissipate into space and form part of the general interstellar gas.

The relative number of atoms of neutral and ionized calcium in some of these clouds can be found from the intensities of their lines, and hence the number of electrons. It appears from this that, in interstellar space, there is something like one molecule per cubic centimeter. The theory of gases shows that for this density the mean free path of a molecule should be about 100 times the Earth's distance from the Sun.

This is only 1/600 light-year. For a density 1000 times less, the free path would be 1000 times greater, but even this very low density would not permit two clouds to pass through one another; they would be inextricably mingled.

The question how so many separate clouds of gas can have continued to wander about within the Galaxy without becoming dissipated is, therefore, no easy one. The discovery of the clouds is so recent that there has not been time for mathematicians to attack the problem—much less to publish their results. In due time much more will doubtless be known about this fascinating question.—*Manitou Springs, Colorado, May 19, 1943.*

Science Enters The Woods

Research Shows that Good Forestry Practice Can Provide a Permanent Pulp and Paper Supply

C. E. RANDALL
United States Department of Agriculture, Forest Service

We aren't shooting any paper bullets at the enemy these days: We want the bullets we mark for Hitler's and Hirohito's minions made of sterner stuff. Nevertheless, we'd be hard put to fight this war without pulp and paper. A lot of paper work is back of every military action and every war production job. It takes many reams of paper for the necessary blue-prints or maps, specifications, and orders. From the same source—pulp—comes cellulose for textiles, photographic film, medical supplies, plastics, and filters for gas masks. More than two million cords of pulpwood will be needed this year for shipping containers to get supplies to our fighting men overseas. Then, too, the dissemination of war news and other important and vital information in newspapers and magazines can continue only so long as a supply of paper keeps coming along.

It is estimated that no less than 14 million cords of rough wood will satisfy 1943 pulp and paper requirements. And that is only a part of the wartime demand on the forests. Wood is a critical war material; wood is wanted for ships, planes, gunstocks, docks, cantonments, factories, railroad ties and telephone poles, ammunition boxes, and hundreds of other war needs.

In the past, it was considered practically axiomatic that the woodyard of the United States was limitless. On that presumption, axes and saws ravaged forests from one end of the country to the other. Today, large areas of former forest land are no longer productive. It doesn't take an expert to figure out that if you continue to cut off timber without adequate provision for new growth, some day the wood supply will run short.

Scientific woods management, say foresters, is the Aladdin's lamp which will lead to continuous supplies of pulp and paper. Unlike minerals, timber is a renewable resource, and forest lands can be managed to insure continuous crops.

Spruce, which is peculiarly suited for newsprint papers, has long been the dominant pulp timber species. Relatively pure stands of spruce in the Northeast, near large markets and cheap water power, influenced early establishment of mills there. However, as a result of technical developments, many other species are now going into pulp and paper. Jack pine, hemlock, aspen, and other species feed numerous mills in the Lake States. The ability to use western hemlock opened the way to extensive development of the pulp and paper industry on the Pacific Coast. In recent years new plants of huge capacity have sprung up in the pine regions of the South. However, neither cheap power, nearness to markets, nor the industrial genius and push of men behind the industry will be able to maintain it indefinitely unless attention is given the growing of raw material.

How to perpetuate the valuable pulpwood species and increase the timber growth on pulpwood lands are problems of vital concern. Research indicates that in most cases the productivity of pulpwood lands can be increased considerably. Any effort in this direction necessitates intelligent forest management based on scientific forestry.

The techniques vary greatly with different regions and timber types. In the Northeast, extensive pulpwood operations have frequently led to over-cutting of softwoods, resulting in a deterioration of the spruce-fir types, often with low-value hardwoods coming in to dominate the stands. The major problem usually centers around development of practical cutting methods that will guarantee continuance of advance reproduction, and cultural measures designed to protect and develop existing stands of reproduction to full timber crops at maturity.

Prior to actual cutting, it is important that the pulpwood producer classify his lands on the basis of kind, size, and density of the advance reproduction, bearing in mind that much effort may be wasted in attempting to maintain softwoods on sites distinctly favorable for the production of hardwoods. With stands properly classified, the progressive order in which areas are to be cut, based on their maturity and reproduction conditions, can be determined and adhered to insofar as market and logging conditions permit.

Because attaining an advance reproduction of young growth above two feet in height is a highly important factor in successful spruce management, logging may be so organized that cutting on any specific area can be regulated to permit seedlings to attain this height before the protective cover provided by the main stand of mature trees is removed.

Dependence on advance reproduction necessitates extra care in logging to reduce damage to a minimum. Large numbers of thrifty young spruce and fir may be destroyed needlessly on every acre by careless timber fellers. Studies indicate that this damage often ranges from 20 to 40 percent. This destruction, particularly marked in the two- to five-foot height classes of spruce and fir, is unfortunate since it is this height class that responds more vigorously when it is "released" by removal of the older timber and possesses the best prospects of winning out against the fast-growing hardwoods and attaining a permanent position in the new stand.

When adequate reproduction is lacking, foresters recommend removal of one third to one half of the stand so as to open it uniformly and permit the establishment of additional reproduction under shelter of the remaining trees. Ten to fifteen years later, if conditions are normal, sufficient reproduction will have come in, and the remainder of the old stand may be logged.

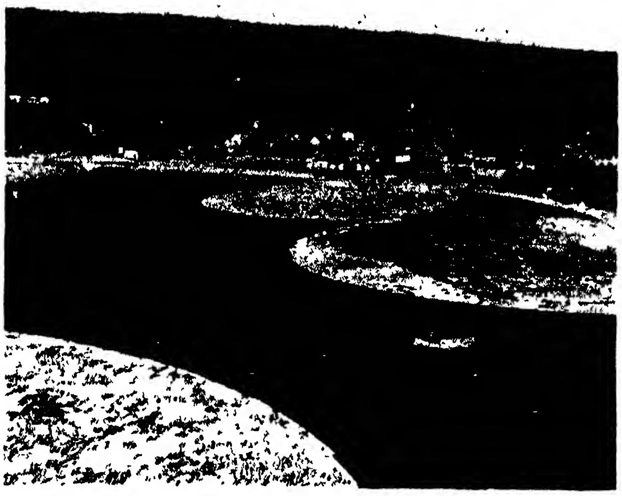
Southern yellow pines have come into rapidly increasing use since the introduction of the sulfate pulp industry in 1908. The sulfate or kraft process is particularly adapted to the pulping of resinous or pitchy woods.

Farmers produce quite a bit of the pulpwood consumed by pulp mills in the United States—in the South, the figure is as high as 55 percent. Clear-cutting to supply the timber and pulpwood markets,

Although 16 cords per acre were removed from this southern pine forest, 57 percent of the volume of wood was left standing under scientific cutting

particularly on farm woodlands, and recurring fires have, however, made serious inroads on the productive capacity of forest lands in many areas in the South

Fortunately, old Mother Nature is a persistent forester. In the South, if fire is kept out, Nature will in time usually provide a new stand of trees. Nature works a lot faster, however, if man co-operates, and foresters are therefore continually working to bring science to the "piney woods." Under most conditions, selective cutting is the recommended practice in the South The larger trees may be removed from a thrifty stand, and another cut will be ready before many years. Selective cutting thus maintains a continuous growing stock, and it provides frequent cuttings and larger returns over a term of years than clear cutting which removes all salable timber.



Upper left: **Piling spruce pulpwood. Supervised cutting here assures sustained yield.** ***Center:*** **Spruce pulpwood, cut into 50-inch sticks, in the harbor at Grand Marais, Minnesota.** ***Below*** **A paper company's pulp yard containing 250,000 cords of wood**

In harvesting timber crops, pulpwood may be taken out along with poles and sawlogs, yielding several timber products in one operation In young stands, thinning and improvement cuttings may be used to improve growing conditions and at the same time yield substantial quantities of pulpwood. The important thing is that enough trees be left to maintain a satisfactory rate of growth to the acre.

The advent of new pulp and paper mills in the South increased the danger of too heavy cutting in many woodlands. In the vicinity of some of the older mills the farm woods have been virtually wiped out because of unrestricted cutting in the wake of timber contractors' activities. The region surrounding Monroe, Louisiana, and parts of southern Alabama and western Florida bear notable witness to such devastation.

Often a woodland owner has not known a better way than the traditional one of clear cutting everything merchantable. The idea of regulating cutting for sustained yield from woodlands, with resultant continuous cash returns, is still foreign to many.

A few years ago, for example, farmers in a certain Texas county sold their timber rights to a professional buyer of wood for a Louisiana pulp mill 150 miles away. The buyer made a bargain to cut everything on the farmers' woodlands by paying the almost unbelievably low price of three dollars an acre, and the contracts gave him the right to remove the timber over a period of years. Much of the land had stands ranging from 10 to 20 cords or more to the acre, growing at the rate of about half a cord or so to the acre every year. The farmers got a stumpage price of only 10 to 30 cents a cord, and in addition they continued to pay taxes on the land.

Pulp mills in the South have recognized the danger to their industry and the welfare of the community from the common practice of overcutting woodlands, and accordingly are taking steps to encourage adherence to certain forestry standards in cutting timber for pulpwood.

Scientific forestry, however, is still the exception rather than the rule on privately owned lands, not only in the South, but in all forest regions. And from privately owned lands come 90 to 95 percent of the nation's total wood supplies

Technical foresters don't yet know all the answers. Further research will be necessary to determine the most successful and economical measures for producing maximum timber crops on a sustained yield basis in various forest types and regions. However, it has progressed far enough to indicate the general requirements for keeping forest lands productive.

It takes almost twice as long to cut and peel 100 cubic feet of pulpwood from trees 5 to 8 inches in diameter as it does from trees 11 to 17 inches in diameter. Cutting undersized trees similarly wastes additional time in loading, unloading, and milling. Restricting cutting to trees of mature pulpwood size steps up production from 20 to 30 percent per man day. To tie up men and machinery cutting and processing immature timber is an inexcusable waste of manpower, equipment, and resources in these emergency days.

New developments in pulp and paper are being introduced all the time. Cellophane is an example of a pulp product whose widespread use expanded almost overnight. Wood plastics are growing in importance. A new laminated paper plastic developed by the United States Forest Products Laboratory shows promise for use in aircraft construction and for many peace-time purposes.

Foresters maintain that if scientific woods management practices are universally applied, the forests of America can be made to supply all our wood requirements and more, in perpetuity. An expanding pulp and paper industry backed by a permanent supply of raw materials could benefit social and economic security in the post-war years. It could provide substantial support for rural-industrial communities in several sections of the country; it could help to stabilize agriculture by affording many farmers a year-'round income; and it could help supply the people of this country with an abundance of the material things that make for a high standard of living.

Elmer Sperry and His Magic Top

How an Inspired Inventor with an Ancient Toy Altered the World of Marine and Aerial Navigation

FRANCIS SILL WICKWARE

On a summer day in Cleveland, 39 years ago, a slight, blue-eyed man named Elmer Ambrose Sperry bought a toy top and carried it home to his children. He spun it on the living room floor, and one of the children asked:—"Daddy, why does a top stand up when it spins?"

It was an old, old question. Mathematicians had written tomes about "gyroscopic inertia." But no one had ever found a way to utilize this strange physical force.

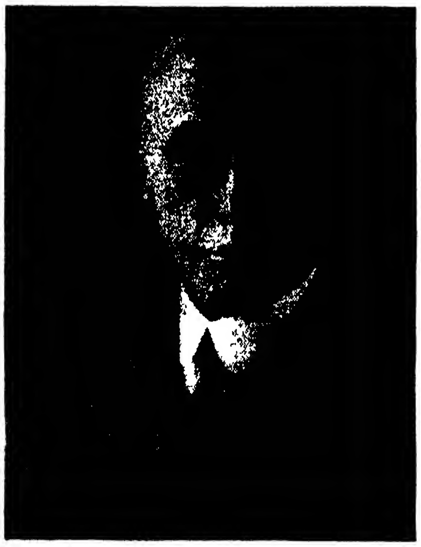
Sperry—then aged 44, and already famous as the inventor of an arc light, a new system of electric propulsion for trolley cars, and a long list of other things—pondered the top. It was his first step on the long road toward his invention of the gyro-compass that bears his name. This invention changed the world. The gyro-compass revolutionized marine navigation and, without it, long-range aviation as we know it could not exist. Transatlantic flights and 2000-mile hops between pin-point islands in the Pacific would be out of the question. Precision bombing would be impossible. For the gyroscope was the forerunner of the directional gyro (for direction keeping and for showing the amount of turns), the artificial horizon (which shows the pilot whether he is in level flight), and the turn and bank indicator (which shows the rate at which the plane is turning). Gyroscopes are an integral part of the Sperry and Norden bomb sights, while the Sperry automatic pilot—which automatically flies the heaviest plane through any kind of weather—is essential in determining the proper course during the crucial moments before the bombs are released.

But that day in Cleveland, Sperry foresaw none of these things. He was aware only that the child's question nagged him.

Sperry first waded through the technical literature then borrowed an electrically driven gyroscope from a scientific school. It was a simple instrument—a solid steel wheel on an axle, mounted within gimbal rings so that it could be turned in any direction. That is, it could be turned when the wheel was at rest. But when the motor spun the axle at 3000 revolutions per minute it became difficult to budge the wheel out of its plane of rotation. The frame could be turned in any direction—the wheel held steady. Sperry pointed the whirling axle toward the sun, and watched how it stubbornly held its direction. The spinning wheel *seemed* to turn over within its frame once every 24 hours. But actually it steadily pointed at the sun. The sun doesn't move, and neither did the spinning wheel. *The world revolved around the gyroscope.*

For months Elmer Sperry was obsessed with the spinning wheel. At such times he had to be reminded to eat, and invariably forgot to take any money with him when he went out of the house, with the result that he ran into embarrassing situations on street cars and in restaurants.

Sperry first proposed building a gyroscopic stabili/er to keep the top-heavy old-fashioned automobile on an even keel on the high-crowned roads of the day. This was not feasible. A little while later he took a trip to Europe. In a storm at sea he was thrown out of his berth and wrenched his knee. He was indignant—why should man be at the mercy of the ocean?—and immediately decided to do something about it. Couldn't the gyroscope be used to stabilize a ship and prevent it from rolling in rough weather? He believed it could. Might not a gyroscopic stabilizer improve naval gunnery by keeping ships steady during the firing?



Above: Elmer Sperry—almost 400 patents. ***Right:*** Sperry's modest birthplace in Cincinnatus (population 800) in central New York State. He was a student at the Cornell University for two years

The Navy showed cautious interest. After three years of tests and deliberations, Sperry built a full-sized stabilizer for the destroyer *Worden*, a notoriously unsteady craft. The stabilizer made the *Worden* ride like a canoe on a mill pond. But cost and weight of stabilizers were a drawback—and as a matter of practice the ship's roll is useful to naval gunners, who thereby get increased gun elevation and range.

However, Sperry gyro-stabilizers were installed in many large private yachts, and years later the Italian liner *Conte di Savoia* was fitted with three 80-ton gyros at a cost of over $1,000,000. There was so much publicity about this installation that the Italian company had to stop advertising it. People insisted on traveling on that one ship alone.

Steam had replaced sail long ago, and steel had driven the wooden ship from the seas. But nothing had been done to improve the compass, an ancient Chinese invention which never deserved its reputation for accuracy. For one thing, the needle did not point to true north but to "magnetic north," a broad, uncertain area in northern Canada. Steel hulls threw the compass needle off the beam. Steel superstructure also deflected it. Any metallic cargo added further uncertainty. In certain parts of the world—notably the Great Lakes—iron-ore deposits made the compass particularly wild. In submarines it was entirely useless. Often it took days to adjust compasses before a ship could sail.

Elmer Sperry felt sure that his gyroscope was the answer. Once fixed on true north it would stay fixed. It could be placed anywhere on the ship, and would not be distracted in the slightest by magnetic influences. The problem was to couple the spinning wheel to a compass card, and to mount it so that it would not be thrown off by the ship's motion, or by the terrific shock of a broadside fired in battle.

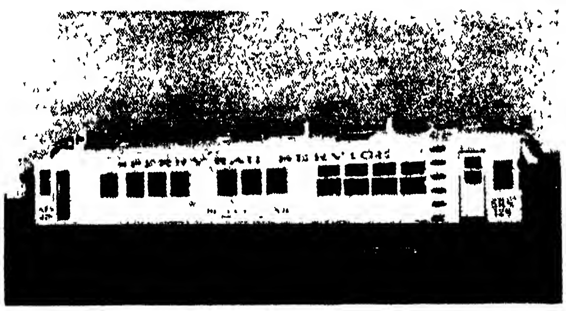
Sperry worked slowly, with great labor. Finally, in 1908, he triumphantly announced that he had perfected the gyro-compass—simple, sturdy, foolproof, and efficient.

This news caused a great stir in the Navy. The gyro-compass was taken out for final trials in the *Delaware*, then our newest and finest battleship. The compass was set up in the base of the conning tower, with repeater compasses on the bridge, and the decisive test came when the *Delaware's* guns thundered a salvo that smashed lights and crockery and sent men reeling against the bulkhead.

At this moment a ditty box which a sailor had carelessly stowed on a platform halfway up the conning tower came tumbling down and thudded squarely on the compass, scattering handkerchiefs, photographs, and assorted personal belongings among the outraged officials. Elmer Sperry just fainted. When he revived the compass still pointed serenely toward true north, and all was well. Reminiscing later about the compass tests, Sperry said: "On such occasions there comes over me a welling up from within, a sort of elation, and life takes on a new and exalted aspect. That is living!"

The Navy at once started equipping all ships with the gyro-compass, and orders arrived from the British, French, Russian, Italian, and Japanese navies. The last skeptics were convinced when a gyro-compass guided the British submarine E-11 through the nets, mine fields, and swirling currents of the Dardanelles to the harbor of Constantinople, where it destroyed much shipping.

Today all submarines depend absolutely on the gyro-compass, not only for underwater navigation but for accurate firing of torpedoes. The torpedoes themselves are steered by gyroscopes. Practically every first-class ocean-going vessel in the world carries the Sperry compass, despite its minimum cost of $6500. Originally our Victory ships were planned for magnetic compass operation, since there was a scarcity of gyro-compasses. But the demagnetization of the ship that is necessary to neutralize magnetic mines so affects the operation of the magnetic compass that we are now putting gyro-compasses on them.



Top: **The old *Delaware,* first naval vessel to be equipped (1911) with a Sperry gyro-compass.** ***Above:*** **The original compass as installed on the *Delaware.* Some of the parts were built by Sperry himself.** ***Left:*** **A modern Sperry detector car. Within are generators that deliver 4500-ampere currents to test rails**

Most modern merchant ships also are equipped with the Sperry Automatic Pilot, or "Metal Mike," which can steer a ship straight across the ocean with no human helmsman on the bridge. "Metal Mike" is so uncannily accurate that at first superstitious native pilots refused to stay on board with it. They thought the Devil was steering.

Two years ago, the Navy launched the submarine tender *U. S. S. Sperry,* honoring the inventor not only for his contribution to navigation, but for the way the gyroscope transformed naval gunnery. Gun-pointing used to be done visually. But now an officer in the foretop a hundred feet above the deck spots a target over the horizon, superimposes the bearing on a gyro-compass, has it transmitted instantly to all battle stations by repeater compasses, and thus enables gunners to hit distant objectives entirely out of sight. Unaffected by the ship's yawing, the gyro provides for accurate gun-pointing.

Sperry's place in aviation is just as important. Even before World War I, Sperry started adapting the gyro-stabilizer for use in airplanes, mainly to make the air safer for his son Lawrence Sperry, a determined pioneer flier. It was a bitter blow when Lawrence was drowned in the English Channel in 1923, after his plane was forced down by motor trouble. But this only made Sperry more eager to do for planes what he had accomplished for ships. Gradually the basic flight instruments were developed and perfected Each instrument is a marvel of precision, beside which a watch is coarse and clumsy. The raw materials in the directional gyro are worth only a couple of dollars, but the fine work necessary brings the cost of the finished product to more than $300.

Of all the miracles of modern science, surely one of the greatest is a huge bomber or transport roaring through space at hundreds of miles per hour, buffeted by the winds, cut off from sight of earth by clouds or darkness, yet following a true course, with its every movement controlled automatically by tiny gyroscopes. Elmer Sperry made the miracle possible.

The gyroscope also has uses on land. For example, it is useful in oil-well drilling. Formerly, there was no way of controlling the direction of a drill thousands of feet underground. Bore holes wandered as much as half a mile off course, frequently ending up in territory belonging to someone else. There was no remedy for this until a special gyro developed by Sperry was harnessed as a subterranean direction-finder. Now bore holes can be drilled accurately to any depth.

The gyroscope created a great industry. The Sperry Gyroscope Company is today one of the biggest war plants in the New York area, and one of the most secret, closely guarded factories anywhere in the world. It is a technological wonderland behind closed doors, pouring forth —in addition to gyroscopic equipment— a staggering assortment of instruments which serve as the mechanical eyes, ears, and nerves of modern war. Without these instruments—mostly labeled "confidential"—we scarcely could control our own weapons.

The gyro-compass is not the only reason why engineers and scientists rank Sperry second only to Edison. When he died in 1930 he had nearly 400 patents in his own name, covering inventions which ranged all the way from electric coal-cutting machinery to a chemical process for extracting tin from scrap metal. One of his most important inventions was a searchlight which creates "the brightest continuous light ever made by man." Sperry built the first model for the Navy during the last war. It evolved into the 60-inch searchlight which now is standard equipment in all U. S. anti-aircraft batteries. The eight hundred million candle-power beam actually is as bright as sunlight. It can be seen 200 miles away, and it is easy to read a newspaper in its beam at a distance of several miles. A small model of the lamp is used in motion-picture projectors in thousands of theaters. Without it, clear projection would be impossible in large theaters like the Radio City Music Hall in New York City.

Everyone who rides a train is indebted to Sperry for a vital contribution to railroad safety. For years, one of the chief causes of wrecks was the unpredictable collapse of sections of rail. Rails that looked all right would suddenly give way under the weight of a train. All railroads had tried desperately to find means of detecting the hidden cracks, but without suc-

(*Please turn to page* 84)

The Culprit Is Histamine

A Substance Normally in Our Body Cells Makes Trouble When it Escapes into the Blood Stream

L. W. GIELLERUP

IT WAS one of the hottest days of the year in Rochester, Minnesota, yet at high noon a man limped into the famous Mayo Clinic wearing a heavy overcoat and spats. His ears were tucked under furry ear muffs, and, as it developed later, he was snugly swathed in heavy woolen underwear. The Mayo doctors found the bewrapped gentleman's complaint to be as odd as his dress. It was so simple—he just couldn't keep warm!

Within a year, thousands of miles away in London, England, a man was rescued from the wreckage wrought by a Luftwaffe bomb. Following routine treatment this victim was discharged. For a few days he seemed to be in perfectly normal health. Then he suddenly dropped dead

These seemingly unrelated events had a curious association. The shivering patient in Rochester, Minnesota, and the air-raid victim in London, England, were brothers under the skin. They were related by blood, in the sense that their veins harbored the same mysterious substance which had brought chronic misery to one and sudden death to the other They were victims of similar allergies

These curious cases have played significant roles in one of the most striking medical developments of our times, a triumph of scientific deduction which may well have a vital meaning to countless sufferers from allergies to foods, pollen, ivy poisoning, and some leading types of chronic headaches. Common allergies are universal and costly menaces to human health and happiness From Aunt Martha's "migraine" to the mysterious behavior of air-raid victims, the allergic keep many a physician playing hide-and-seek with the baffling symptoms inherent in these disorders. Often, these symptoms may resemble those common to a well-known complaint. Yet orthodox treatment fails to bring relief.

The most striking feature of common allergies is the wide divergence of the symptoms. Naturally, it was a real triumph when medical science discovered that the same substance which burdens some people with a lingering lifetime of allergic misery, may also cause the collapse and sudden death of persons suffering from serious shock. Here the culprit is histamine, a substance manufactured by the body itself. The real significance of histamine in common allergies is known only to a relatively small group of medical men. But the British discovery of histamine's lethal powers has stimulated world-wide interest in the subject. Here is how London physicians tracked down the killer.

Victims extricated from bomb-blast wreckage are hospitalized as "crush injuries," meaning that they have been under pressure. The skin of a "crush injury" may show only a few welts, a wheal or two. Usually there is a degree of nervous tension. After routine treatment patients may seem to be normal for a time, but without warning they may suddenly collapse and die. These cases are not to be confused with the well-known phenomenon of soldiers found dead on the battlefield without apparent cause. Here is the difference. The "crush injury" victim of air-raid wreckage suffers from the *secondary* effects of bombing—the debris and its insidious pressure. The seemingly related battlefield fatalities result from the *direct* impact upon the body of high-velocity sound waves. Modern shell-bursts cause serious internal disruptions of the human mechanism. Without creating a single surface wound the action of these waves contributes to shattering the lungs in a thousand places.

The wreckage-bound victim of an air-raid also reacts to pressure but the damage is close to the surface. Though the skin is whole, careful examination will reveal crushed muscle cells due to steady and powerful pressure on the confined parts. Whether the ordeal has lasted a few hours or more than a day, the duration of the "crush" bears no relation to the final outcome. At this point the cases became first-class medical mystery. Painstaking autopsies revealed nothing directly related to the fatal result of the "crush injury" until—well, medical science simply rolled up its mental sleeves and started remembering.

Way back in 1909 there had been experiments by Drs. Baylis and Cannon The muscles of animals were confined, circulation blocked. When the pressure was removed and normal bloodflow released, shock followed and the animal died. Later, Sir Henry Dale, professor of pharmacology at the University of London, discovered that the "crushed" muscles of such animals contained a something called histamine. This substance was released into the bloodstream from the debris of the crushed muscle cells. Dale's deduction that this histamine substance caused the fatal shock is one of the accepted medical theories today. Well it might be. The same shock, observed in the experiments, was produced by injecting histamine into normal animals!

One notable thing about histamine is its potency. One one-millionth part in the bloodstream can cause intense physical distress. This seems to be true in the direct action of histamine, as in "crush injuries," and in the sensitivy to external substances, as in allergies. It was only natural for medical science to reason that if histamine can set the stage for the death of its sensitive host, what about the non-fatal damage of less though abnormal concentrations? The far-reaching implications of this question and their possible significance to millions of people, easily raises the subject of histamine research to the level of the vitamins and sulfa drugs.

The nature of histamine, how it operates in serious body disturbances, is extremely interesting. Histamine is a protein associated with the everyday food proteins beloved by nutritionists. You may recall that proteins share the spotlight with those other basics in foods, the carbohydrates—proteins the major constituents of meats, carbohydrates the rulers of the "starchy" foods. Histamine is normally in all living body cells, but it gets into the bloodstream when cells are injured. One accepted medical belief is that histamine is set free by destruction of tissue. The action of bacteria, too, can unleash this blight; even exposure of the body to light. Theoretically histamine can act like allergens, body substances which make some of us so sensitive to pollens, dust, poison ivy, and the circumstances producing hives. Allergens may also be connected with the more sinister phenomenon of shock.

To give the devil his due, histamine has its good side Normally it is a stimulant to many muscles and glands. But when it is itself goaded, the substance inhibits the tiny blood vessels of histamine-sensitive people. These vessels, which regulate the blood supply, lose their function. This is a step toward shock The removal of a simple tourniquet from an injured limb may bring on shock thought to be due to an increase of histamine in the bloodstream. This is histamine acting directly The allergic action of histamine is often demonstrated in a homelier way by a condition called dermagraphia, or skin writing. Perhaps you have never met a human writing pad, but such people are not at all uncommon. When the flesh of these individuals is inscribed with a pointed object, the characters appear like magic in red welts. The reason is this: Even light pressure injures the tissue cells. Histamine is released, causing the welts, engorgements of the local blood vessels, wherever the pressure occurs.

It seems a long jump from the pressure of a pencil on the skin, to being buried alive in bomb-blast wreckage, or even to reactions caused by pollens, cold water, or poisonous plants. But, medically speaking, unfavorable reactions to these experiences may simply represent different levels of allergy. This demonstrates better than any funeral cortege that the real importance of histamine research is in its application to the many who may be sensitive to the substance in different but extremely vital degree.

Medical research is increasingly con-

cerned with the millions who suffer at some disturbing level from chronic ailments due to obscure causes such as allergies. Science is speeding important research on the relation of histamine to such mysteries as hay fever, migraine headaches, the common cold. The principal conclusion of science on this subject to date is that it takes histamine, or related substances, to fight a histamine susceptibility. The modern principle in the treatment of allergies mirrors the homeopathic doctor's ancient dream—to cure the disease with its cause. Doctors know that histamine susceptibles must be handled with elaborate caution. Desensitization to the substance must proceed from infinitely tiny doses through almost imperceptible increases. The physician must have the patience of Job to avoid an overdose and the resulting shock. To patients, the relief from the misery of histamine sensitivities is well worth the strain of the treatment. Take ivy-poisoning susceptibles, for example.

There is glad news for millions of such sufferers in a scientific report tucked away in America's leading medical journal. Dr. Joseph Moss, of Durham, North Carolina, theorized that allergy to poison ivy might in some way be related to histamine sensitivity. For a laboratory he chose a summer camp infested with poisonous ivy growths. Eight persons were used as subjects. All were known susceptibles to ivy poisoning. Four were given daily doses of a drug in the histamine family. The other four subjects served as "controls" All eight were exposed continuously to poison ivy for ten days. Result: None of the subjects who had taken the desensitizing drug developed ivy poisoning. Two of these four, who had been poisoned during the preceding summer, survived deliberate attempts to contract the ailment. Two of the four "controls" who went drugless contracted ivy-poisoning, "one rather extensively."

Later a group of 35 campers took the test. Nine who had been poisoned by ivy the summer before were given the drug for 25 days. The other 26 persons were "controls." One of the nine subjects dropped out. Result: Ivy-poisoning struck 13 of the 26 "controls." But only one of the eight taking the drug came down, and the attack was confined to a mere patch on the knee. Four of these subjects, all allergic to the weed, actually *rubbed* it on their skins!

Dramatic, too, is a feat of research by Dr. B. J. Horton, a Mayo clinic allergy expert. For intuitive and courageous procedure, Dr. Horton earns a medical palm Recognizing that headache, a supposedly simple, everyday ill, causes tremendous physical misery and economic loss to millions of people, Dr. Horton has long applied his skill to the relief of this widespread ailment. His experience gives an excellent preview of what histamine therapy may mean to the world to come Actually it is much easier for a physician to diagnose and remove an infected appendix than to pin down the causes of many types of chronic headache. During an extended clinic Dr. Horton catalogued many headache symptoms. From careful records he discerned definite patterns. One that recurred frequently was an excruciatingly painful condition centering in the victim's eye. Patients described it as the sensation of "a knife being driven through the head."

With the strange consistency of some human ailments, the attacks came with deadly regularity at the victim's bedtime. Sleep could be had only by sitting up in a chair. Most patients confessed to suicidal thoughts. Some had resorted to serious operations. Marshalling his knowledge of histamine, Dr. Horton decided to try an experiment. He injected the patients with pure histamine. Upon such intuitive decisions of physicians depends much of the world's good health. To Dr. Horton's own surprise the injections consistently produced attacks of the ailment. The conclusion was obvious. The sufferers were allergic to their own histamine, which, in mysterious concentration, struck savagely in the area of the eyes Why the eyes? Dr. Horton does not know to this day A series of desensitizing "vaccinations" with histamine relieved 76 of 78 serious cases

Dr. Horton christened the disease "histaminic cephalgia." *The Journal of the American Medical Association* carried his statement that histamine is as specific in this ill as insulin is in diabetes!

Score another triumph for the belief that many allergies may stem from the individual's own histamine. Dr. Miles Atkinson, of New York City, reports on the histamine treatment of sufferers from "Ménière's syndrome," which, roughly speaking, is to the ears what migraine is to the head. Dr. Atkinson writes that injections of histamine are successful in relieving patients who are hyper-sensitive to the substance.

Another striking application of histamine therapy is the research of Dr Horace Hill, Medical Superintendent, Laverstock House Mental Home, Salisbury, England. In the "shock treatment" found beneficial for dread schizophrenia (split personality) and manic depressive (heavily brooding) psychosis, Dr. Hill injects patients with histamine and insulin The benefits, Dr. Hill believes, come not from the shock, but "from some chemical body as histamine." Physicians in America have used this technique with greater benefits than the crude "shock therapy" of suddenly dropping the patient through a trap-door, or placing him in a rapidly whirling chair.

Astonishing 30-day cures of long established hives cases resulted from oral administration of a drug which neutralizes histamine. The same drug relieved the histamine-sensitive of skin eruptions and acid stomach. Even rheumatoid arthritis and swelling of the legs and arms have been benefited Dr. Louis E Prickman, of the University of Minnesota, believes that histamine therapy offers great possibilities in the correction of food allergies due to histamine sensitivity.

However, it must be remembered that only the histamine-sensitive can hope for such miraculous results. It is quite likely that a great deal of the world's minor and major ailments could be cleared up by a general "vaccination" of all persons against possible histamine sensitivity. But that is mere day-dreaming. The cost would be fantastic, the organization of general densensitization incredibly involved. Unfortunately, "vaccination" against histamine sensitivity is apt to be a long drawn-out affair. It is true that the poison ivy experiments accomplished apparent immunization in periods of 10 and 25 days. But, even so, this can hardly be compared to the low cost and minor inconvenience of the single shot-in-the-arm techniques widely used against the better-known diseases.

It seems pretty obvious that any moves on the histamine front are bound to be private affairs. The individual, if sufficiently interested, will have to take the time and trouble to consult a physician qualified to determine by test his or her reaction to history-making histamine.

• • •

CHILD CANCER

Cancer Is Not Confined to Middle and Old Age

EVEN CHILDREN may have cancer—in fact, infants sometimes are born with it. In the professional journal *Radiology*, statistics on child cancer, on the basis of the census, indicate that approximately 150,000 persons died of cancer in the United States in 1939, and approximately 1100 of these were less than 15 years of age, or 0 7 percent. Taking vital statistics of Massachusetts for the same year, it is shown that the death rate from cancer in childhood was greater than for pulmonary tuberculosis, measles, diabetes, scarlet fever, or typhoid.

Thus the rather common tendency to smile increduously when cancer in children is mentioned is not justified by the facts. It can happen here.

WHOSE FAULT?

Nobody's—And Certainly Not the Mother's

IF A *pater familias* ever harbored a secret (or expressed) grudge against his spouse for "delivering him," as the old expression went, daughter after daughter without any sons, it is now his time to retire from the argument as softly as possible before the lady finds out, as she ultimately is likely to do, that human sex "is determined," as *The Journal of the American Medical Association* states it, "by the presence or absence of a particular gene or set of genes of the father rather than by the mother."

This astounding fact is based on research performed by the geneticists and is actually experimental, not merely theoretical. Genetics is today one of the soundest branches of biological science.

In the next phase of popular knowledge of the remarkable fact just stated, the long-suffering mothers are likely to turn the tables by demanding that the husbands themselves do something about it. But there is nothing they can do for the matter is entirely out of human hands.

OUR *Point* OF VIEW

HOW EASY IS HINDSIGHT!

IN A combative, newly-published book, "The Wright Brothers, a Biography Authorized by Orville Wright," Fred C. Kelly demonstrates what is incontestably true—that it took the editor of Scientific American a long time to come to the point of believing that claims for the early Wright flights were truthful. Nearly three years elapsed between the Wright's first powered flight and this magazine's full acknowledgement, in the number for December 15, 1906, of "their epoch-making invention of the first successful flying machine."

In the light of what everybody now knows, such a delay seems difficult to explain—difficult, in fact, to comprehend—especially when three more years are added, as they must be, for the Wrights' previous gliding experiments, those of 1900, 1901, and 1902 at Kitty Hawk. Does it not seem strange, especially to readers who were not yet living at the time, that Scientific American did not currently describe and closely follow the long annual series of experiments from the outset? What, then, was wrong?

The chief thing that was wrong is one that still is "wrong," namely, that in human affairs there is no known formula for dead-sure prescience. From the vantage point of what we know today the early Wright experiments stand out like a beacon light. When they were being made they remained as obscure as a light under a bushel. In all the history of science and invention there scarcely ever was an instance so strange in this one respect: That public awareness of events which it seems today should have spread like a forest fire, and which could not by the utmost caution have been kept secret, actually kept themselves almost secret and spread only by the most slow, gradual smouldering. In an age of publicity writers this will be difficult to grasp. Let us go back.

In 1900 the Wrights sought a location where winds were steady over flat open country. Weather Bureau data showed that Kitty Hawk, North Carolina, was suitable. The Wrights had not sought a secret place, yet had they done so they could scarce have found one more likely to afford that commodity.

Three autumns at Kitty Hawk—those of 1900, 1901, and 1902—taught them enough knowledge of glider control to tackle powered flight. They still were without publicity. They did not deliberately seek it but they did not fight it. And if at the end of the second year's work Wilbur Wright could say that not within a thousand years would man fly, how can we today expect that people of even less faith then would feel otherwise, strongly enough to bring them to Kitty Hawk to report the events going on there? The Wrights were not regarded as crackpots; simply they went rather unnoticed.

The first power flights took place at Kitty Hawk late in December, 1903. Orville Wright, the one now living, flew for 59 seconds. It seems probable that if the world had learned to be as receptive of new inventions and discoveries as it is today the Wrights would at that point have sprung into a limelight that never would have diminished. But the world's psychology was unready. A nearby newspaper, the Norfolk *Virginia-Pilot,* treated the news of the 59-second flight as important but only five of 21 big-city papers ordered the story when it was offered them; two of these did not print it. The news was still a match that hadn't enough body of flame to it to ignite a log, and after its brief moment it went out.

Kelly, the author, divides editors of the period into two groups of disbelievers: Those who didn't believe the flights had taken place at all and those who saw no importance in them. For had not the distinguished scientist Simon Newcomb only two months previously proved by mathematical logic that heavier-than-air flight was impossible for man, and had not Professor Langley once more failed in an attempt to fly only two weeks before that?

If Kitty Hawk was so remote as to be a factor in the seeming unreality of the asserted flights, was a field only eight miles from Dayton, Ohio, so remote as to have a similar damping effect of remoteness on public credulity—especially as two highways and an interurban car line passing it permitted full view of the Wrights' powered flights of 1904 and 1905? Scarcely so, yet the suburban farm might almost have been at remote Kitty Hawk. The Wrights prepared for a powered flight, sent written invitations to Dayton and Cincinnati papers—and only 35 persons turned up, 12 of them reporters. When motor trouble prevented the plane from lifting, most of the reporters *knew,* as they *had all along,* that it was a hoax; and when the next day more motor trouble cut the flight to 60 feet, the rest went home to stay and forget it.

"During all their experiments that year and the next," Kelly states, "the Wrights had all the privacy they needed." The match again hadn't ignited the log or the forest.

The Wrights flew and flew and flew on that field in 1904 and 1905, in plain sight of a sightless world. They had plenty of troubles but worked up to five-minute flights, 18-minute flights, 25-minute flights, 38-minute flights, but it still wasn't news! You could draw a circle around that field, beyond which nobody saw or apparently cared. Even Fred Kelly, the author of the new book, reporting for a nearby Dayton daily, was sure it was all nonsense—yet in the same book he "pans" Scientific American for paying no attention when the publisher of a magazine on *bee culture* wrote an eye-witness account of the Wright flights and sent the editor of this magazine a marked copy!

Thus it was that, a year later, the Wrights were still a forgotten secret because Dayton newspapers were waiting for them to "do something unusual" before risking in their columns space that might be used for more profitable purposes such as local society notes. And instead of making the most significant event of the century known to the outside world, Scientific American was publishing in its issue for January 13, 1906, a statement of its disbelief in the alleged Wright flights: "If such sensational and tremendously important experiments are being conducted in a not very remote part of the country, on a subject in which almost everybody feels the most profound interest, is it possible to believe that the enterprising American reporter, who, it is well known, comes down the chimney when the door is locked in his face—even if he has to scale a fifteen-story skyscraper to do so—would not have ascertained all about them and published them broadcast long ago?"

Scientific American's mistake—and it made one—lay just there: The enterprising Dayton reporters obviously weren't so enterprising as our trusting editors believed. It was they, primarily, who kept the Wrights' big news in a vacuum. And Fred Kelly at the time—so says his own book—was a reporter dwelling only 11 miles from the Wrights' experiments!

It is not as if Scientific American had always ignored or belittled the Wrights' flights. Eighteen months before the editorial comment quoted above was written it had stated (in the number for June 11, 1904) that "the flying machine invented by Orville and Wilbur Wright, which made a successful flight at Kitty Hawk, N. C., last December, had another trial near Dayton, O., on May 26, which the brothers say was successful." What transpired in the next 18 months to cause the editors temporarily to become doubters we today know not.

Kelly tells how in 1940 Dan Kumler, who was city editor of *The Dayton Daily News* during the years in question, parried embarrassing questions and then gave in. Asked why there was nothing in his paper, he replied, "We just didn't believe it. Of course, you must remember that the Wrights at that time were terribly secretive." "You mean they were secretive about the fact that they were flying over an open field?" "I guess," said Kumler grinning, "the truth is that we were just plain dumb."—*A.G.I.*

Oil From Canadian Sands

Billions of Barrels of Oil, but Not for Lubrication, May be Drawn from Northeastern Alberta

LEONARD BOURNE

In the widespread search for new and undeveloped sources of vital materials needed for the successful prosecution of the war, an area of some 10,000 square miles of mineral-rich oil sands in the northeastern regions of Alberta may prove to be an invaluable aid and to provide much weight to the eventual knockout punch to Axis dreams of world conquest.

At McMurray, a few hundred miles north of the capital at Edmonton, is real wealth in oil—huge quantities of it, estimated to be enough to supply the world's needs for the next hundred years or more; oil with an amazingly high ductility that may help solve the problem of supplying synthetic rubber to the armed forces of the United Nations, as well as for civilian requirements. This oil is also producing an asphalt of excellent quality in sufficient quantities to surface the entire length of the recently completed Alaska Highway.

High octane gasoline, tractor fuel, Diesel fuel, coke, and asphalt are the immediate products in view from the Alberta oil sands and quantities of each have already been recovered from this "black gold." So important is the area considered that plans have been under advisement for the construction of a $20,000,000 plant that will add considerably to the United Nations' oil reserves. Already a half-million dollars have been appropriated by the Dominion Government for the development of existing plant equipment and for research directed toward the solving of some of the still present problems in the extraction of oil from the extensive sand deposits. The potential importance of these oil sands to the Allied military plans is great indeed, for this vast region lies within reach of America's newly built lifeline to Alaska. With Russia's vast Caucasus oil fields endangered earlier by Nazi advances toward Stalingrad, these deposits in Alberta take on vital significance. Produced here in great quantities, fuel oil and high-octane aviation gasoline will facilitate the supply problem to our northern outposts and the Pacific.

How much oil is there in this fabulous region?

Nobody really knows, but American and Canadian geologists say that a hundred billion barrels are within the realm of possibility and that even 250 billion barrels are not too high a guess. Then remember that the present known oil resources of the world are perhaps 35 to 40 billion barrels and the extent of the potential development of the oil sands begins to take on astronomical proportions.

The fact that the Alaska Highway was completed ahead of schedule, opening a direct supply line to defense posts in Alaska and the Pacific, has speeded up other aspects of the drive for raw materials.

Blasting out sub-surface oil deposits

Results of investigations made last summer have not been fully revealed but recent action by the Canadian Government strengthens the belief that no opportunity to increase supplies of natural wealth is being overlooked. The Canadian budget estimates, recently made public, include provisions for income tax deductions by prospectors, mine operators, and oil operators. Pre-production expenses, according to the altered income tax schedules, may be written off against the income from new oil-well production or the production of vital base minerals. Other concessions, too, are included in the new tax program to encourage and stimulate interest in prospecting for these needed materials.

Specific plans with regard to increasing production at the McMurray oil sands region are still not complete, however. One of the principal considerations includes the building of a pipeline from McMurray to Edmonton, but the problem of securing material for such a pipeline at this time may be found insurmountable. Other means of transportation, however, are not only feasible but are now being employed despite temporary difficulties and a resulting reduction in the facility with which oil can be moved.

These Athabaska oil sands of Alberta are not newly discovered; they have been known for many years, but because of their inaccessibility, little was done to develop production on a commercial scale. White men first heard of this strange vast resource in 1719, when an Indian brought samples of "gum or pitch that flows out of the banks of rivers" to a fur trader on Hudson Bay. Peter Pond and Alexander Mackenzie, two of the revered names in Canadian exploration, left long and glowing accounts of these river banks where Indians dug out pitch to mend their canoes.

The sands are an ancient delta or estuary deposit, washed into a shallow sea many million years ago and later buried beneath accumulations of sediments. In time, these were consolidated into sandstones and shales. At some time and in some manner about which there is still much speculation, the sand became saturated with heavy oil. More recently, the Athabaska River and some of its tributaries have cut valleys through the overlying rocks and through the oil sands, leaving benches or shelves in the oil sands, some of them of large extent, along the valley walls.

It is probable that no other mineral deposit has been the subject of research over so long a period of time. Much of the pioneer exploration was conducted by S. C. Ells (F.R.G.S., F.G.S. of London) of the Dominion Mines Branch of Ottawa, who revealed the potential resources of the vast area. In 1913 the first tests were made in an area then largely unsurveyed and known only to trappers and northern natives. Core drilling, sampling, a study of mining methods in conjunction with the excavation of tons of these bituminous sands, and exhaustive laboratory studies contributed toward the actual operations that materialized only recently.

It remained for Max W. Ball, one time member of the U. S. Bureau of Mines and for many years a successful geologist, to develop a method of "mining" the sands successfully. The oil is found at depths of from eight to perhaps two hundred feet below the surface, hence open pit extraction is possible. Light blasting followed by power shoveling is used to ex-

cavate the oil-bearing sand; in fact, the blasting actually starts the separation of the sand grains from the surrounding oil film. Conveyor belts carry the sand to the separation plant where, by means of flotation, the oil is completely separated from the sand.

This is the method employed at the Abasand Oils Ltd., plant at McMurray where Mr. Ball's experiments over a period of 12 years now make it possible to recover oil from the sand deposits in a matter of minutes.

Actually, commercial production has become a problem in economics rather than engineering. Production costs are pretty well established, but transportation costs, the extent of a stable and assured market, and problems of expansion are important factors.

Original estimates revealed the oil sand deposits to average 15 to 17 percent oil content. Operations now are limited to more than 4000 acres in the Athabaska River region around McMurray, for which the mining rights have been issued, and except for two or three small tracts, present leases cover all the known mineable deposits within 45 miles of the present railhead at Waterways. These sites have been selected as being most suitable for the open pit mining methods now in practice and it is highly probable that only these deposits will be worked for another generation or so.

Plant operations now reveal a steady production rate of 300 barrels of oil daily from the processing of 400 tons of oil sands. On this basis, and with the required plant expansion envisioned, production of 10,000 to 20,000 barrels of oil

So rich in oil are some of the sands that oil can be squeezed out by hand

per day is quite feasible. Carrying these estimates further, officials anticipate production of 100,000 barrels of oil to the acre of these valuable deposits.

Assuming that oil from the sand deposits is exact and steady, at 10,000 barrels daily, it could be laid down at the refinery for 75 cents now and two years later it would still be produced at the same basic cost.

It is estimated that it costs 83 cents to produce the average barrel of oil at

A general view of the open-pit mining area at the McMurray, Alberta, pilot plant, where oil-sand deposits are found at a depth of 15 feet below the surface

American wells; taking it to refineries averages perhaps another 25 cents, or a total of $1.08, which figure could conceivably fluctuate but still be higher than the Alberta estimate. Most oil fields decline from their peak production; as the fields grow older, pumping and other production costs increase. But the open pit mining methods at McMurray made possible by the accessibility of the oil deposits at depths close to the surface, eliminate any fluctuation in production costs

Present production is more than adequately covered by the market demands Gasoline, Diesel fuel, and fuel oils produced from the Alberta deposits are already being shipped to the North A heavy freight rate advantage over products from competing refineries is explained by the fact that the McMurray deposits are 500 miles nearer to their markets; hence, transportation costs are lowered.

The principal markets for asphalt products, aside from the anticipated use in surfacing the Alaska Highway, are to the south of the McMurray plant. Small sections of Alberta roadways surfaced with this native asphalt have proved extremely economical and substantiate the belief that, even produced in large quantities, the demand might well exceed the supply. There are roadway sections in Edmonton built of this McMurray oil sand asphalt which have never required major repairs in more than 20 years. Pavements of other refinery asphalt require repair almost every year and in some cases must be completely replaced every five or six years.

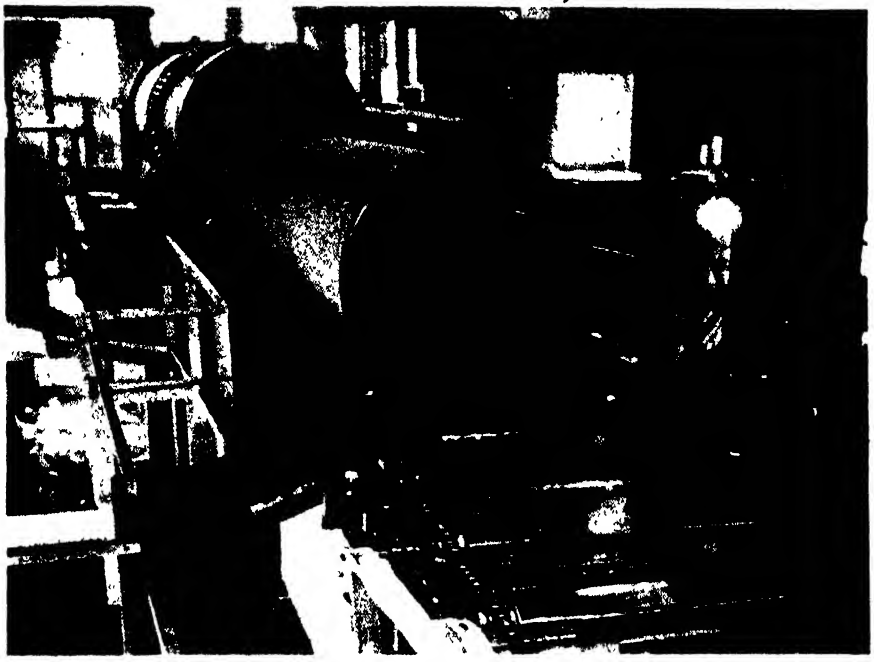
Alberta's native oil sands have been weathered for more than 100 million years, learning the hard way to contract and expand in temperatures ranging from 90 above to 56 below. Consequently, the asphalt product is peculiarly adapted to the surfacing of public roads throughout the northwest and will solve one of the major problems in year-'round maintenance of the Alaska Highway. Weathered by nature and possessing qualities of persistency that make frequent repairs unnecessary, the Alberta oil sands product eliminates the repair cost factor.

Asphalts from McMurray, for example, can be delivered for about 10½ cents per gallon, F O.B Edmonton, in tank car lots This is the same price for which asphalt can be delivered from Calgary, Alberta, refineries as a by-product of the Turner Valley oil fields. Even with tankage scarce, it could be shipped in barrels at a slightly higher cost, but the superior quality of the McMurray product would more than offset the increase.

THE VERY quality which makes for perfect asphalt also renders the crude useless for the manufacture of lubricating oil It has never been exposed to the tremendous pressures to which deep-well crudes have been subjected. It is very susceptible to heat and therefore it cracks down at relatively low temperatures. On the other hand, this quality makes possible the manufacture of all types of fuel which require low flash point.

The lighter products—gasoline, Diesel fuel, and fuel oils—are already fueling the steamers, tugs, and other river craft which ply the Athabaska, the Slave, and the Mackenzie Rivers. It likewise fuels the Diesel engines, gasoline motors, boilers and heating appliances of the mining camps in the far north. Everything from bunker oil, including the kerosene categories, to the highest octane ratings, can be produced.

All contemplation of future developments of this area are allied with the Alaska Highway. Canadian and American authorities see this road not merely as a wartime emergency lifeline to de-



Oil-bearing sand is fed into the large drum in the background where hot water accomplishes the separation by flotation. The separated oil is then carried into the tanks

fense outposts, but as a postwar route opening the doors to almost unbelievable expansion and development of the northwest and its natural wealth and resources. These will, of course, be urgently needed in the reconstruction and stabilization period following the end of hostilities.

In this postwar development, the McMurray oil sands will play a vital part, even if they should not, for one unseen reason or another, become directly harnessed to the present war effort.

Larger deposits farther down the Athabaska River from present operations are estimated to contain 300,000,000 barrels of oil. To work them successfully requires a plant to produce and digest an average of 10,000 barrels a day, to connect this plant by pipeline with the railhead at Waterways, and to erect a complete refinery at Edmonton at a total cost of about eight million dollars. Such expansion would assure production of 10,000 barrels a day for 20 years before the plant need be moved; this figure could be stepped up to even 30,000 barrels a day, with no further burden such as is involved in drilling additional wells.

Construction of a 300-mile pipeline from plant to refinery, no matter what it costs, is considered economically desirable. Since the supply of oil is unlimited, the amortization on this pipeline could be extended over a period of 30 to 40 years instead of the usual ten-year period as in the case of most oil lines

Probably of greatest significance in considering the future of this vast mineral wealth is the matter of a permanent supply of basic materials for the manufacture of synthetic rubber. Because of its high ductility, Athabaska oil sands are considered a likely source of butadiene, an important basis for the manufacture of synthetics. Once the ultimate development is launched and butadiene is produced in large quantities from this source, a national economy independent of supplies of raw natural rubber can be established

• • •

Orphan Agar

But Poorly Known to the General Public, Agar is One of the Nation's Most Critical War Materials

HAROLD KEEN

Add to the nation's critical war materials, alongside rubber and many metals, a white, semi-transparent, tasteless, odorless, gelatin-like mass—agar. Without it our military machine might well bog down in a complication of hygienic problems, and our public health and sanitation systems might be seriously disrupted.

In laboratories where bacteria in the military or civilian supply of water, milk, and food must be constantly checked to prevent wholesale contamination, agar is an irreplaceable bacteriological culture medium which, unfortunately, the United States has long depended on Japan to provide.

When the Japs attacked Pearl Harbor, agar automatically became a scarce commodity within the United Nations. Since a Japanese peasant three centuries ago accidentally discovered nature's alchemy which mysteriously transformed gelidium, a small dark-red seaweed, into a jelly-like substance of gastronomic attraction, energetic Nippon had built a world monopoly from the harvest at its shores.

Amputation of the Japanese supply left us with an agar stockpile of about 200,000 pounds—sufficient for only one year's maintenance of healthful food, milk, and water standards.

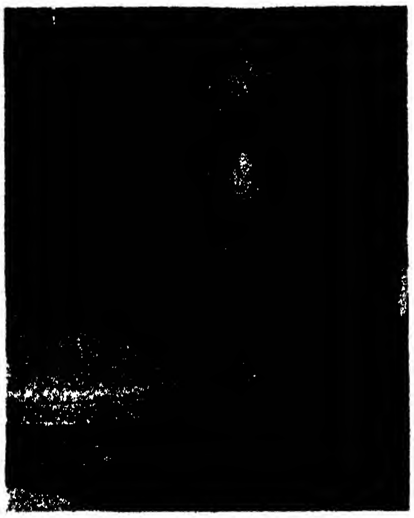
Thus agar came under the whiplash of the War Production Board, which is-

Shoveling seaweed into washing tank for soaking to remove foreign matter

sued a conservation order "freezing" the material and prohibiting its employment anywhere except in bacteriological laboratories. Much of the 600,000 pounds imported annually by the United States had met a wider variety of consumer uses—for jelled desserts, as a stiffening medium in candy, ice cream, and pastries, as a coagulant for clearing beverages, as a sizing agent in cloth, for dental impressions, and in combination with laxatives and mineral oils to overcome constipation.

As W.P.B. learned, science has never found a pinch-hitting ersatz for agar. It is the only substance known to have the peculiar properties needed in an effective bacteriological culture medium. Briefly, it withstands sterilizing temperatures of 248 degrees, Fahrenheit, for 20 minutes, and cools into convenient gel form Unlike animal gelatin, which supports the growth of most kinds of bacteria, very few bacteria digest agar. On the other hand, it holds the peptone, beef extract, and similar nutrients introduced into it to keep the bacteria alive for laboratory analysis—a function discovered 70 years ago by Koch, the German bacteriologist.

Japan became world supplier of this vital commodity, not because it had a corner on gelidium, the plant from which it is obtained, but because its labor costs



In these 1000-gallon autoclaves the weed is pressure-cooked six hours to dissolve out the agar

were low enough to wipe out competition from an American product.

A small group of Americans nevertheless maintained a spark of life in the ill-nourished industry. In San Diego, for two decades, companies have unsuccessfully tried to process agar out of gelidium in the face of Jap underselling.

Hence, southern California, home of the motion pictures and a booming aircraft and shipyard industry, now is serving also as agar storehouse for the Allies. San Diego is almost the geographical center of a great gelidium-bearing region, from Monterey 400 miles on the north to Cedros Island, off the coast of Lower California, 350 miles on the south.

Colossus of United States agar manufacturing today is American Agar and Chemical Company, which a few weeks after the outbreak of war began producing in San Diego the precious material at a rate which has exceeded the 100,000 pound per year mark—roughly half that used annually for bacteriological culture media. The urgency of increased output cannot be overemphasized.

Curiously enough, American Agar and Chemical Company to a large extent owes its strong position to a generous source of supply in foreign waters. Much of its gelidium is harvested off the coast of Lower California, by Mexican divers operating from Punta Banda, near Ensenada, south 300 miles to Cedros Island. The factor which established supremacy of Jap agar in American markets—relative cheapness of labor—is once again being put to practice.

The Agar Company of California, a Los Angeles concern with a plant in nearby Orange, has launched diving operations with an American crew at Newport Beach, swank resort. E. H. Lochridge, manager, estimates that the cost of raw materials obtained in Mexican waters is one half that of domestically procured gelidium. In recent months, American Agar and Chemical Company also has been harvesting gelidium off Newport Beach, but major reliance still is placed on the Mexican supply due to superior weather and water conditions, as well as cheaper labor.

Most important aspect of the agar problem, availability of sufficient seaweed, is a potential bottleneck which the United States Fish and Wildlife Service and the Scripps Institution of Oceanography, at La Jolla, California, a division of the University of California, are attempting to shatter. Marine biological stations and marine botanists have been enlisted in a study to determine the abundance of various types of red algae, and their agar assay, on all our coasts, as well as the Hawaiian Islands, and Caribbean waters off Puerto Rico and Cuba. Simultaneously, experiments on improved methods of extraction have been under way at such research centers as the Scripps Institution, the Marine Laboratory of Duke University, Beaufort, North Carolina, and the United States Fish and Wildlife Service at a laboratory at Bethesda, Maryland.

Of more than 6000 marine algae, about 30 yield agar, but only eight or ten species are extensively used. *Gelidium cartilagenium,* the most common agariferous weed off the California and Lower California coasts, is an habitué of rocky shorelines, clinging in maroon-colored, bushy masses to the tops of rocks lying in water from low tide to about 60 feet depth. Vacationists have collected small sprays of it on California beaches without realizing the lofty place this seaweed occupies in the scientific world.

Harvesting gelidium is strictly hand work. The weed grows, tuft-like, seldom more than one to two feet from the rock It must be located at close quarters by the diver as he walks along the ocean floor, gathering it by hand into a twine basket. Turbulence of the current, an essential environmental condition for growth of gelidium, further precludes use of machinery for harvesting. Sluggish, brackish waters which allow sediment to form on the rocks are shunned by the temperamental weed.

A gelidium diver, struggling against the surging, swirling inshore current, can be no weakling. He must keep himself in trim physical condition to endure the strain of searching for the red algae. The industrious, wiry Japs were ideal for the task.

For almost 300 years, agar has been produced in much the same manner by Japan. In the summer, the seaweeds are gathered in Japanese waters and bleached on the beaches. Baled like hay, the gelidium is transported to Japan's high mountains, where the winter months are devoted to extraction of the agar in crude equipment operated by many family units.

After the weeds are boiled for ten hours, the fluid is filtered and allowed to congeal indoors until it has reached the consistency of soft gelatin, when it is cut into strips or square shapes. These are placed outside on cold nights, and freezing transforms the jelly from a uniform structure to one consisting of filmy cells like that of a beehive. When this is exposed to the sun, the ice crystals melt away, leaving spaghetti-like shreds of trifling weight. In this form, the agar was exported by the Japs, and converted into a jelly merely by placing in a hot water solution.

The manufacturing process in this country, except for mechanical improvements, is essentially the same. The seaweed is gathered, dried, baled, and shipped to the factory, where it is shoveled into a washing tank and cleaned. Next it goes into 1000-gallon pressure cookers and is cooked for six hours. This dissolves out the agar content of the weed to form an agariferous liquor. This liquor is clarified, filtered, and allowed to congeal. Then it is ground into small particles, shaped into 100-pound blocks, and frozen and in that state it is re-ground. After thawing, it is re-washed, chemically treated and dried, ready for shipment and use.

Artificial refrigeration, of course, is employed in balmy Southern California, and the finished product is flaky, instead of stringy. A greater degree of purity is claimed for the domestic agar.

Dr. Marston C. Sargent, of the Scripps Institution, who spent much of 1942 experimenting with methods of obtaining agar from various types of marine algae found off La Jolla, claims that "any enterprising person can make agar out of a surprising variety of seaweeds, using a washtub, a stove, and (in warm weather) a mechanical refrigerator."

"Experience in China, New Zealand, Australia, and Russia," continues Dr. Sargent, "has shown that beachcombers and even school children who have been taught what to look for can gather

Introducing 100-pound block of frozen agar gel into a chopper which grinds the gel to small particles

enough valuable red seaweed to form an appreciable addition to their country's resources and at the same time earn something ranging from pocket money to a good day's pay.

"The fact that, as late as 1929, 300,000 pounds of dried porphyra, a seaweed used as food in China, was collected each year in California by men, women, and children, shows the possibilities of this kind of work."

Dr. Sargent and an associate, Dr. Robert Tschudy, have produced jellies, on a small scale, which showed three times the geling strength of the present commercial output from weeds found off the Institution's shores. Thus, 0.5 percent of their

Drawing by Russell W. Porter

Important sections of the Co-Operative Wind Tunnel are shown cut-away to reveal interior details

agar in solution provided the same geling potency, for use in bacteriological media, as 1.5 percent solution of the material now used.

Still more significantly, they demonstrated that, besides gelidiums, many other weeds plentiful in the inter-tidal zone are agar producers. Whether these can be employed on a commercial scale remains to be determined.

If the United States is to supply agar to its allies for the duration, it has to contend with some truly staggering figures.

The agar requirement of Russia alone, in 1937, was 1,000,000 pounds, compared with the 100,000 pounds a year production at Odessa, Archangel, and Vladivostok. China's needs have run over 350,000 pounds annually, but the loss of its coastal regions has smashed its agar industry, which produced 150,000 pounds in 1936. England has no agar production, and only a very small industry exists on the island continent of Australia and New Zealand.

Evidently anticipating a pinch, Germany imported huge quantities of agar from Japan, and is believed to have a stock pile of approximately 2,000,000 pounds. Japan's production rate has been as high as 6,000,000 pounds, or 3000 tons, a year.

Thus, Nippon alone need not fear a wartime crippling of her public and military sanitation systems through lack of agar.

FINEST WIND TUNNEL

Will Provide Velocities Close to Speed of Sound

The most advanced wind-tunnel in the world is nearing completion. The laboratory buildings for the $2,100,000 Southern California Co-operative Wind Tunnel are now completed and the construction of the steel tunnel itself is well under way.

Soon the tunnel will be ready to serve as the world's most advanced testing ground for the developments now making American airplane performance set new records in speed, altitude, armament, and maneuverability.

The tunnel, financed by Consolidated, Douglas, Lockheed, and North American —all Aircraft War Production Council members—is being constructed and will be operated under the supervision of Dr. Clark B. Millikan, by the California Institute of Technology. An identical twin tunnel, in the east—at Buffalo, New York —is being constructed under the supervision of Dr. Norton B. Moore, of Curtiss-Wright.

Design of both tunnels was in process for many months, under the general direction of Drs. Millikan and Moore. Collaborating were engineers of the four southern California companies, Caltech, and Curtiss-Wright.

Importance of the wind tunnel in the development of better aircraft lies in the fact that much of a new plane's flying data (probable top speed, landing speed, rate of climb, stability, controlability, number of required take-off feet) can be accurately determined in the wind tunnel before the proposed plane is built.

Aircraft manufacturers expect to build planes in the next few years that will have diving speeds exceeding 9/10 the speed of sound (approximately 741 miles per hour). Airplanes of the future may be designed to dive at a rate of more than 700 miles an hour. The new tunnel will be equipped to test at such speeds. Most existing tunnels have a maximum testing speed far less than this, and only a few are capable of testing at speeds exceeding 500 miles an hour. In the development of high performance military aircraft, problems requiring immediate wind tunnel testing almost always occur in the design phase and particularly during the flight test period when immediate access to a wind tunnel is of vital importance.

Wind tunnels operate on the principal of the Venturi tube, which was devised in 1800 by Giovanni Venturi, an Italian physicist, for measuring the flow of water through a pipe.

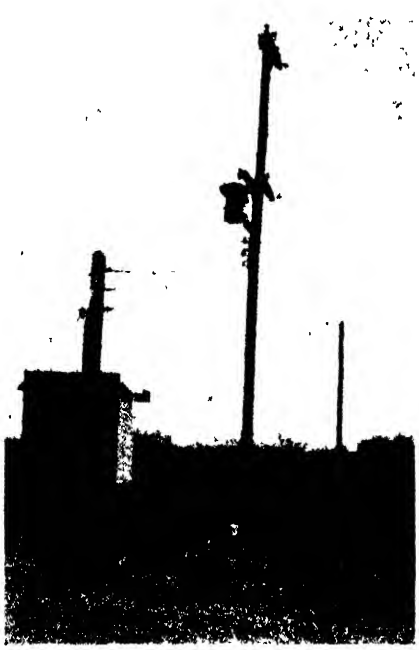
Substituting wind for water, air is moved by a huge propeller in a section of large diameter. From there it is blown into a much smaller section, the "throat." When the wind in the large section of the tunnel reaches the "throat" it gains in speed.

By placing an exact scale model of an airplane in the "throat," tests can be made

which will show what the actual plane will do when it is in the air at similar speeds. Reactions of the model (placed on supports resting on highly sensitive balances) are measured mechanically, electrically, or hydraulically. Readings are taken for every attitude of the model in the tunnel and the recorded information is immediately plotted on a graph. Engineers are then able to list accurate flying characteristics of the future airplane.

ELECTRICAL PROTECTION
Reduces Upkeep Cost of Pipe Lines

PIONEER work on electrical protection of pipe lines is today helping save steel for battleships and bombs. So severe is the corrosive action of salt water on the steel in a net-work of lines near Port


Pipe-line transformer and rectifier

Arthur, Texas, that the stretch of swampland has become known to Gulf engineers as "Hell's Half Acre." The actual distance between the refinery and tank farm is only 2½ miles, but there are over 19 miles of pipe lines between the two points, including five 10-inch lines and three 8-inch lines. It was costing the company $15,000 a year to maintain these lines. This was before 1935.

In 1937, at a cost of $17,000, the installation of electrical protection to the pipes in this corrosive salt marsh was made. Since then the frequency of rust holes has been reduced to practically nil. Maintenance costs have been reduced about $10,000 per year. The only direct charge per month is $50 for purchased power.

Electrical protection of pipes is at present restricted to the pipe exterior. A typical circuit involves the use of a source of direct current such as a motor-generator, wind-driven D.C. generator, or rectifier. The positive pole of the direct-current source is connected to a ground bed buried in the earth between 100 and 500 feet from the pipe. The current flows from this ground bed through the earth to the pipe to be protected. The current is picked up by the pipe and flows along it to the negative terminal of the direct current source, thus completing the circuit. The ground bed is usually composed of either junk steel or graphite surrounded by coke.

Corrosion of steel pipe occurs because of differences in electrical potential on the pipe face. It has been found that when the electrical current flows to the pipe from the remote anode, it flows first to the areas having the lowest potential. The hydrogen evolved raises the potential of these cathodic areas to the level of the anodic areas and thus, by eliminating the potential differences, corrosion ceases.

This installation by the Gulf Oil Company, and others, have definitely proved the worth of electrical protection to the oil and gas pipe-line industry. The result is that much lighter pipe, usually coated with enamel and wrapped with asbestos, is now used, saving tons of vital war-needed steel annually.

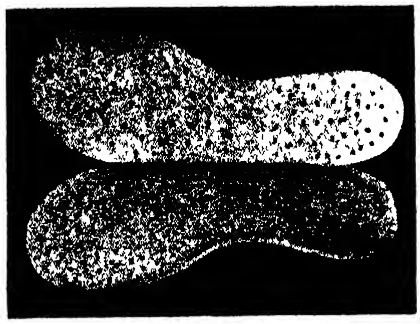
• • •

PLATING—Landing gear struts for military airplanes are chromium plated twice as fast by using a tube of "Lucite" methyl methacrylate resin to protect the strut's threaded end during plating.

• • •

WARM INSOLES
New Design for Use in Cold Regions

RECENT research into the foot comfort of military forces in the Arctic regions of Canada, Alaska, and Greenland, has led to the design of a new "ventile" wool felt insole which incorporates several important innovations This insulating insole has been made to meet the difficulties encountered in various types of footwear tested by hunters and trappers who have lived in the Far North for years, as well as Antarctic explorers, Army Engineers Corps, salvage parties, patrols, airplane pilots, and others of the armed forces. The name "ventile" (generic; not trade) was coined by members of a recent expedition to express the ability of a bodily covering to ventilate by "breathing." This important property permits moisture from perspiration to be exhaled, whereas non-porous coverings retain moisture, which forms ice and becomes an important


Ventilated, hinged, warm

source of discomfort and danger. This is true even when extraordinary precautions are taken to prevent the conduction of heat away from the body.

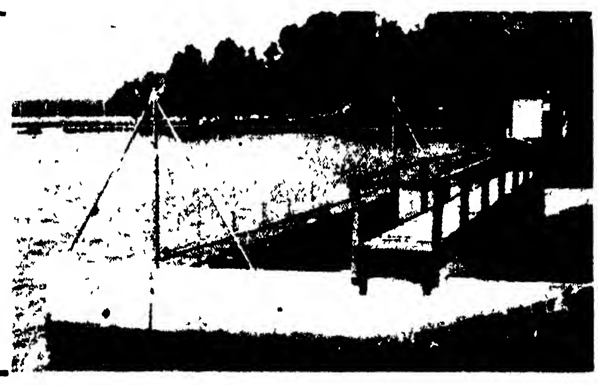
The new ventile insole differs from the usual type in that it consists of two layers of wool felt totaling one half inch in thickness; these are hinged at one side by a stitched seam This seam runs for about five inches along the outer edge of the instep and permits the upper and lower layers to "work" under the intermittant pressures of walking.

Both layers are also perforated, having approximately one hundred holes ⅛ of an inch in diameter spaced ⅜ to ½ of an inch apart. This construction has been tested for both ease and warmth, with highly promising results on both counts.

The type of wool employed in the felt for these insoles is selected for its tendency to loft itself when released from pressure, instead of matting down and losing the springy support. It is antiseptic and fungus-proof and will not stretch when washed, if properly handled.

FISH SCREEN
Electrically Operated, Keeps Fish Within Bounds

REPLACING more bulky and less satisfactory mechanical fish screens, a new electrical device has been developed which will fence off sections of a stream, the outlet of a lake, or the entrance to irrigating systems so that fish cannot pass, yet logs, sticks, leaves, and other debris will flow down stream. The screening is achieved through the use of an electric current which is sufficiently powerful to keep fish away from the electrode, yet will not stun or kill them The current is furnished by an electronic impulse generator conected to electrodes which swing freely in the water.


An electric fish screen installed at one of the outlets of a California lake. The hanging electrodes clear the lake bed by about three inches

Conservation possibilities, using the Burkey electric fish screen, include confining fish to certain areas; diversion of up-stream migrants to fish ladders or counting devices; segregating sizes and species in hatcheries; protecting bathers by a harmless electrified zone which will effectively keep away sharks, barracuda, and other dangerous fish life; and the solution to other problems which constantly arise in connection with fish culture and control.

CORROSION BATTLE

Being Waged With

Electronic Diffraction Camera

ARMED with a vacuum tube "machine gun" that shoots billions of electronic bullets a second, a Pittsburgh research chemist is making a new scientific attack on rust and corrosion. With this new weapon—an electronic diffraction camera —Dr Earl A. Gulbransen of the Westinghouse Research Laboratories, is investigating the atomic structure of coatings that "grow" on steel, aluminum, and copper when these metals are exposed to air or corrosive chemicals.

Dr. Gulbransen is shown in our cover illustration at his new form of "target practice" which is pointing the way toward longer-wearing bearings and cylinders for airplane and automobile engines, better tin plate in which the tin will cling more tightly to the steel underneath, and cheaper methods of making stainless steel.

"Just as some types of bacteria are beneficial to human beings," Dr. Gulbransen says, "some of these oxide coatings protect the metal underneath them. Others, of course, like rust, are harmful. With this electronic camera, we are testing new theories as to how these coatings are formed."

Electrons are shot down through the three-foot-long vacuum tube and bounced off a highly polished button of metal on which an oxide coating is being built up. The electrons ricochet off the faces of the block-like molecules that form the coating and continue downward at an angle to strike a strip of photographic film.

The electrons trace on the film a pattern of black and white semi-circles which appears when the strip is removed from the camera and developed. This design is formed by the electrons bouncing off the different faces of the molecules in the coating.

The polished metal buttons which Dr. Gulbransen uses as targets are inserted six at a time in a magazine which fits into the side of the vacuum tube. By revolving the magazine he can bring any one of the buttons into the field of electronic fire. Electric resistance wires in the magazine heat the buttons to accelerate the formation of coatings. Dr. Gulbransen can also speed up the growth of the oxide coating by turning valves to admit measured amounts of oxygen into the tube. Another valve pours cleansing hydrogen into the tube. This gas combines with the oxygen in a coating and forms water vapor which is pumped out of the tube before a series of experiments is started.

Just as a pinch of salt can improve a recipe, small amounts of alloy metal can alter the nature of the coating formed on a piston ring, cylinder wall, or motor bearing, Dr. Gulbransen explains. Iron, for example, acquires an "overcoat" of rough iron oxide when exposed to air but when one percent of chrome is added to the iron the coating formed is chromium oxide, a thin, protective layer that hinders the oxidation of the metal.

"There are two factors involved in the growth of these coatings," Dr. Gulbransen says. "One is energy. Metal ions, atoms which have lost some of their surrounding electrons, require a certain amount of energy to travel through the oxide layer to combine with oxygen atoms. Free electrons making this same trip also need energy. Sometimes, travel is in the opposite direction, with oxygen ions moving inward to build up the oxide on the surface of the metal. When we heat the metal, we give these particles more energy, they make the trip more easily, and the coating builds up more quickly.

"The second factor is entropy—which means chance or opportunity. Even when ions and electrons have the energy necessary to go over the 'hill' between metal and air, many never complete the trip. They fail to find the proper path and fall back down the hill, thus slowing up the rate of rust or corrosion."

NYLON IN TIRES

Giving Good Service

Under Severe Conditions

BOMBER tires, containing strong sinews of nylon beneath their rubber surface, have given a good account of themselves in a year of action in the Pacific War Zone. Placed on planes of a type giving the greatest tire trouble, the performance has been eminently satisfactory.

With tough and supple nylon sinews

The tires have been subjected to punishment beyond anything in the experience of civilian motorists. The huge ships, sometimes weighing 25 tons or more, hit the ground at high speed, 100 miles an hour or more, on front line fields, necessarily small and requiring quick stops. With the landing brakes jammed on, the tread portion of the tire carcass actually buckles and folds back on itself. A tire must be tough to stand this torture. Nylon tires have demonstrated they "can take it."

Although nylon tires still are in an experimental stage, with some problems remaining to be solved, scientists engaged in the work assert they meet the most severe form of the standard bruise test without breaking. This test, made in a tire manufacturer's laboratory, involves pushing a blunt cone-shaped plunger down upon the tread of an inflated tire until the tire bursts. When this test was applied to 9.00 inch tires made of the strongest material in commercial use, they burst when the plunger had sunk six inches. Applied to 9.00 inch nylon tires, inflated to the same pressure, the plunger forced the inside of the tread clear to the rim without breaking the tire; and when the plunger was withdrawn the tire sprang back into shape, without a sign of injury.

RADAR

Background of the War's

Greatest Development

THE recent lifting of certain Army-Navy restrictions pertaining to radar has been like the turning of the page of a magic story book. Now is revealed the part played by the American radio industry functioning in co-operation with the United States Navy and Army Signal Corps in the development of the revolutionary wartime science of detecting and ranging by radio. As an epic story of American teamwork between scientists and military-naval men, radar is an outstanding illustration.

Basic research work on apparatus and techniques for the locating of ships and planes by radio was instituted by the Radio Corporation of America as early as 1932, when experimental equipment was constructed. Apparatus completed in 1934 was used for a series of co-operative reflection tests with the Signal Corps. Immediately, the Army indicated an interest in the possibilities of developing apparatus for detection of aircraft and ships.

Encouraged by this response, RCA continued tests to determine what performance toward this end might be expected. With further development and improvement, the early apparatus indicated possibilities of much better performance than the sound locators then in use. By demonstrations and discussions, the Army and Navy were kept in touch with the RCA research. In view of military applications, no publicity was given to this development.

During 1937, operating equipment was completed and tested, indicating the distance and position of reflecting objects, in much the same form as is now used in a large part of modern radar equipment. These developments had so grown in importance to the military services dur-

ing 1937 that RCA was requested to put all of this work on a secret basis. As early as this date RCA is reported to have delivered experimental radar apparatus to the Signal Corps for aircraft location tests. Westinghouse and RCA produced for the Signal Corps portions of its first radar apparatus, such as was in operation at Pearl Harbor, on December 7, 1941. It is a matter of record how radar warned of the approach of Japanese planes on that fateful morning, but the operator's report went unheeded since his superior officer, knowing that a number of American planes were due from the mainland, believed that the radar had spotted them, and therefore took no action.

Like many inventions in radio, radar is attributed to no lone inventor. Since it draws upon many radio devices and circuits, various men of science have contributed to its development. Nevertheless, there are a number of radio men whose work has been directly concerned with putting it together and with the development of components that made it practical. The basic research of Commander A. Hoyt Taylor and Leo C. Young, of the United States Naval Aircraft Radio Laboratory, and Dr. John H. Dellinger of the Bureau of Standards, in studying the Heaviside surface and radio echoes, added much knowledge that helped to open the way to radar. Prominent also has been the work of Dr. Irving Wolff, whose early experiments with radio reflection soon led into radar principles. He has been intimately associated with radar research work, while a staff of research workers have been under his direct supervision.

During 1937, it is claimed that Westinghouse developed the key electronics tube for the first United States Army radar equipment for detecting enemy aircraft by means of invisible beams of radio waves.

Supplementing its present mass production of radar equipment, work on apparatus to "beamcast" radio waves is being conducted in the Westinghouse laboratories by a staff of specially recruited physicists and engineers in cooperation with the National Defense Research Committee, the United States Naval Research Laboratory, and the United States Army Signal Corps.

This research work is a continuation of studies begun nearly 10 years ago when Ilia E. Mouromtseff observed that radio transmission was being interfered with by highway traffic. Every time an automobile passed along the highway between the two buildings where the work was being carried on, the radio signals rebounded.

In September, 1940, it was radar equipment, utilizing the rebounding effect, which enabled the outnumbered Royal Air Force to turn back Adolf Hitler's previously invincible Luftwaffe, according to Lord Beaverbrook. It was also radar units, installed in British fighter planes, which provided, at least in part, their defense against night bombers by enabling them to locate and intercept the enemy in the dark. The British called their device the radiolocator. The American name for the new system is radar, an abbreviation of "Radio-Detection-and Ranging."

Radar beams, traveling at the speed of light, can be aimed at definite, predetermined places instead of fanning out in all directions as do the radio waves transmitted in the ordinary commercial broadcast.

Radar's advantages over the outmoded acoustic detectors, whose large listening horns were once familiar sights in news reels, are speed and range. Sound, picked up by an accoustic detector, travels at around 700 miles an hour, only about twice the speed of a fast bomber. But short waves carry the warning of approaching planes with the speed of light —186,000 miles a second. And they do this highly important war-time job over much greater striking distances.

Radio waves, on striking an obstacle, are reflected somewhat as sound waves are reflected to make an echo. The shorter the wave the clearer the echo or reflections; hence short waves are most successfully employed in radio-locators because their reflection is sharper.

A peacetime application of the echo principle is the absolute altimeter, an airplane safety device using short-wave transmitters and receivers. The transmitter sends earthward very short waves which are reflected into the air after

striking the ground. The receiver picks up the reflected waves and actuates instruments on the panel board of the plane to tell the pilot how far above the earth he is flying.

Radar functions as an absolute altimeter in reverse. The transmitter sends its waves from the earth into the clouds to probe the sky like an invisible beam of a searchlight. On striking the surface of an enemy plane, the beam is reflected earthward, where it is picked up by a radar receiver. These devices accurately indicate not only the position but also the distance of the approaching plane.

SPRAY GUN

For Insects, Has Plastic Parts

WHENEVER a manufacturer of a consumer product is forced to find a wartime substitute for critical metals, the consumer is usually the gainer. A recent case is the insecticide gun shown in the accompanying illustration. If you are used to the old tin and brass kind, you will be pleasantly surprised when you

No metal parts to corrode

bring home one of the newest wartime models. It is lighter, easier to manipulate It has a squat, broad-based bottle which will not tip over easily. It has no metal parts to rust or corrode.

Standard Container, Inc., in collaboration with Universal Plastics Corporation, developed the new gun. They replaced the old tin barrel with a spiral-wound paper barrel . . . the steel plunger with one of wood and leather. To connect the barrel and the glass bottle, they used molded black cellulose acetate parts. Even the 1/16-inch dispensing tube is made of this plastic material.

WEED KILLER

Permanently Eradicates Certain Pests

POISON ivy and many other noxious weeds can be killed easily with a spray solution of ammonium *sulfamate* (not sulfate), a non-poisonous herbicide which is free from fire hazard and sterilizes the soil for a brief period only. Properly sprayed, weeds are eradicated permanently.

The base of the chemical is sulfamic acid, introduced by Du Pont's Grasselli Chemicals Department as a new industrial chemical less than two years ago. Since then the acid and its salts have been devoted wholly to war uses, but improved manufacturing "know-how" now permits release of substantial quantities for herbicidal-purposes. Supplies are available

for applications around farms, factories, orchards, and military establishments and wherever an ivy poisoning hazard exists that may cause lost-time of essential labor.

Weeds killed by spraying with ammonium sulfamate include poison oak, chokecherry, wild black berries, Russian, Canada, and sow thistles. Weed destruction is achieved by absorption of the chemical into the foliage and thence down to the roots. It has permanent effect on many hardy, deep-rooted perennials heretofore difficult to eradicate. The weed killer is non-toxic to animal life when the recommended dilutions are observed.

Poison ivy and oak are particularly obnoxious in orchards in some sections, presenting a serious hazard in the care and harvesting of crops. Field experiments demonstrate that ammonium sulfamate spray causes no damage if it falls on tree trunks. It should be kept from fruit tree leaves, however.

WHITE TRAFFIC LINES

Made Permanent by Use of White Concrete

White-surfaced pre-cast concrete blocks are being used in several London boroughs for marking traffic lines. The blocks are 9 or 12 inches long by 4½ inches wide, and are generally 3 inches deep. Flat-surfaced blocks may be used, but a rounded or chamfered surface assists visibility; on a block 4½ inches wide a ¼-inch chamfer is enough to improve visibility without being dangerous to cyclists.—*Highway Research Abstracts.*

AMINO ACIDS

Some Essential, Some Not, To Human Beings

How human "guinea pigs" are for the first time revealing the body's needs for amino acids—little-known food elements essential for life and as important as vitamins—was told recently at a meeting at the Nutrition Foundation by Prof. William C. Rose, biochemist and acting head of the University of Illinois chemistry department, who has studied amino acids for 20 years and is an international authority in that field.

The human guinea pigs proved that the 12 amino acids not essential to animals were found likewise non-essential to humans. Eight of the amino acids essential to animals have proved likewise essential in human diets. One amino acid, histidine, which is essential to other mammals, has been found not essential for nitrogen balance in humans. One acid essential to animals remains to be tested to determine whether it is essential in human diets

All previous experiments with amino acids involved animals. It was with animal subjects that Professor Rose in 1935 discovered the tenth amino acid essential for their normal growth, named by him threonine.

Amino acids are the components of proteins, the principal food constituents of meats, milk, and eggs. Threonine brought to 22 the known number of amino acids, and to 10 the number proved to be essential for normal growth of mammals other than humans.

For the past eight months the amino acid needs of humans have been studied at the University of Illinois by feeding synthetic diets to 12 male graduate students selected from a large number of volunteers. Each of the men continued on the diet for from one month to six weeks at a time.

They eat meals that are substantial though monotonous Special crackers contain most of the food elements other than protein. The crackers are spread with purified butter to provide fat. In place of proteins the men drink solutions of amino acids in distilled water flavored with lemon juice. They also take cod-liver oil and vitamin pills.

This diet contains all food elements in proper proportions to maintain weight and the nitrogen balances of the body. After a week or more to check and stabilize the diet, one amino acid is omitted for several days while the effect on weight and nitrogen balance is noted. Then it is replaced to check the return to normal conditions.

PERMANENT ANTISEPTIC

Has Uses in Textiles, Packaging, Industrial Processes

Odorless, tasteless, colorless, are the sensory characteristics of a newly devised permanent antiseptic which apparently

• • •

READERS desiring further information on new products, or research and development work reported in these pages will be referred to manufacturers or additional sources upon request. Address our Research Department, giving specific references, including date of issue and page number.—*The Editor.*

holds promise of finding wide applications in our industrial and everyday lives. This new material, known as Perm-Aseptic, has a dye-like affinity for fibrous and plastic materials. Once incorporated in such materials it has the advantage of retaining its antiseptic qualities for long periods of time and through repeated washings or cleanings.

Tests have shown that Perm-Aseptic not only kills micro-organisms within its penetration area but also inhibits subsequent growths on treated materials. These same tests have indicated that these antiseptic qualities, in the case of fabrics, are effective even after 40 washings; on tooth brush bristles they have been proved effective after 700 washings. This new antiseptic not only kills bacteria but attacks certain fungi as well, thus making possible the control of growths which, uncontrolled, create tremendous annual losses to textile manufacturers, food processors, and so on.

Possible applications of Perm-Aseptic are in the manufacture of paper, in container materials to inhibit the growth of bacteria and mold, in food preservation, and in the protection of textiles for innumerable purposes.

• • •

FIRE RESISTANCE—In treating wood for high resistance to fire, as much as three and one-half pounds of dry chemical per cubic foot of wood is required.

• • •

MOTOR CONTROL

Regulates Speed Through Use of Electronic Tubes

A NEW team of electronic tubes designed to speed up and increase the usefulness of industrial machinery powered by electric motors has been assembled by engineers of the Westinghouse Electric and Manufacturing Company. Key parts of this new electronic device, called Mot-o-trol, are glass and metal tubes which, working without moving parts and acting many times faster than any mechanical device, will replace electric motor-generator sets or mechanical gadgets now being used to regulate the speed of cutting tools, conveyors, and scores of other industrial machines.

Housed in a cabinet smaller than a floor-model radio, the Mot-o-trol provides wide speed ranges, close speed regulation, and smooth automatic starting of direct current motors, the "work horses" of war industry.

"These motors," says Thomas R. Lawson, electronics engineer for Westinghouse, "must be fed just the right amount of direct-current power at the proper time so they will turn a lathe, drive a conveyor belt, or feed metal into cutting tools at the pace required.

"Most industrial plants are supplied with alternating-current electricity but alternating-current motors are unsuited for such jobs because they have only a few fixed speeds, depending upon the motor's construction and the number of times the current alternates. But a direct

current motor receiving its power through these tubes can operate at many different speeds over a wide range—just as you can drive your automobile at speeds ranging from a walk to 80 or more miles per hour by changing the pressure of your foot on the gas pedal."

At present, Mr. Lawson explains, some industrial plants drive their machine tools and other equipment by hitching an alternating-current motor to a direct-current generator and then using the generated power to drive the direct-current motor. Speed is changed by "throwing away" part of the generated power. Others attach belts and pulleys to an alternating current motor and vary the speed of the machine by altering the size of the pulleys.

The Mot-o-trol converts alternating current from the power line into the required direct current by means of two electronic tubes called thyratrons which allow current to pass in one direction only. "Inside each of these power tubes," the engineer says, "is a grid which is connected to a speed-control dial in front of the operator. Turning this dial varies the electrical 'pressure' on the grid so that it acts as a faucet, opening to let more power pass through the tube to the motor or closing to reduce the stream of power and thus slow down the motor."

The speed control dial moves a metal button which rides on a semi-circle of smooth carbon. It can be turned to any desired point, giving an infinite number of speed variations. On the Mot-o-trol control board there are two of these dials, one for forward and one for reverse speeds. In addition, there are push buttons for forward, reverse, and stop.

Direct-current motor speed control

Here's a typical application of the new electronic device: On a machine tool cutting a slot in a large piece of steel, the operator can select the best cutting speed by turning the forward speed control dial. This speed depends upon the toughness of the steel, the depth of the cut, and the cutting tool's quality. Then, by turning the reverse speed dial, he can make the tool return to the cutting position at high speed so that there is little non-working time.

Other electronic tubes in the Mot-o-trol stand guard over the motor. If something goes wrong with the machine being driven so that the motor is under heavy load and drawing dangerous amounts of current, these tubes automatically cut off the power supply before the motor is harmed. The unit can be mounted on or built into the machine tool or other equipment for which it "tailors" electric power. Those now being built are designed to furnish power to motors of one horsepower or less but larger ones can be built for machines requiring more power.

FIRE EXTINGUISHER
Made with Non-Critical Container

FIBERBOARD tubes in a wooden holder form the basis of a new fire extinguisher made of non-critical materials. Reported to be accepted by the Interstate Commerce Commission for the protection of motor vehicles, and carrying the seal of the Underwriters' Laboratories, the extinguishing material, stored in seven-pound fiberboard tubes, is a free-flowing, water-repellent dry powder that extinguishes fires in gasoline, alcohol, wood, and paper, and can be used on fires in electrical equipment.

Elmer Sperry and His Magic Top

(*Continued from page 67*)

cess As trains grew heavier and faster, the danger increased.

Sperry's solution was characteristically simple, and effective. He reasoned that any internal flaw in the rail would disturb the flow of electricity. So he built a special testing car called the "flaw detector," with a dynamo to generate current which was shot through the rails, and a device which instantly recorded any variation in the flow. The crowning touch was a pump which automatically squirted white paint on any defective section of rail. At first the railroaders thought it wouldn't work—too simple. But it has worked for almost 20 years and is working today. Just since the start of this war, Sperry Detector Cars operated by Sperry Products, Inc., for the railroads, have tested 140,000 miles of track and discovered more than 113,000 defective rails—each one a potential cause of a wreck.

To accomplish what he did, Elmer Sperry drove himself unmercifully He was so full of energy that his engineers in the Gyroscope Company sometimes hid behind pillars or filing cabinets at the end of the day when they saw him approaching with his quick, bouncing step and a bright gleam in his eye that probably would mean an all night session He had a peculiar capacity for juggling several ideas simultaneously, and frequently held multiple conferences, outlining a new project to one man, telling another how to prepare a blueprint, and offering suggestions to a third.

Work to him was the only justification for living, and even when he was supposed to be relaxing he never got far away from his work He used to enjoy having his wife or his daughter Helen read to him in the evenings, but as often as not he would hand them a technical article on electro-chemistry, or patent specifications detailing a double connecting rod attached to a crank arm. Patiently they would read, until Sperry would jump up and say, "Now I've got it"—and hand them another technical paper.

Sperry started his career at the age of six, when he invented a horseradish grater for his aunt in Cortland. That was in 1866. When he was 12 he invented a multiple, semi-automatic drill that speeded up the work of a wagon shop in his home town. At 18 he built an improved light and so astonished his neighbors that they collected a fund to send him to Chicago, where he got his start—his initial success financially. He remained an inventor even on his deathbed. It was unbearably hot in New York on June 16th, 1930, and the hospital room where Sperry lay in his last illness was stifling. At three in the morning a cake of ice was brought in and placed in a tub, with an electric fan blowing across it. The room temperature dropped a degree or two, and with a great effort the dying man whispered—"Put some water in the tub It will give more cooling surface."

Those were Elmer Sperry's last words. His inventive mind was busy to the end.

New Products

PLASTIC ADHESIVE AND CLEANER

PROTECTIVE paper used on plastic surfaces such as those on bomber noses and gun turrets, to prevent damage during handling, shipment, and storage, may now be cemented in place by means of a new adhesive developed by E. I. du Pont de Nemours and Company. The adhesive is so compounded as to permit stripping the paper from the plastic without leaving any deposit on the surface.

For similar plastic surfaces which have become covered with grease or other foreign matter a new liquid cleaning material known as Plexi-Glyst has been developed by Turco Products Inc. The material is applied by spraying or by wiping on with a sponge or clean cloth after loose dust that might cause scratching has been flushed off with water.

WRINKLE FINISH

RESTRICTIONS on the use of Chinawood oil have severely restricted the manufacture of standard wrinkle finishes. Recently, however, there has been announced by Mass and Waldstein Company a new line of wrinkle finishes which contain no Chinawood oil yet which will form hard and durable coatings. The regular wrinkle patterns, it is reported, are obtained by the same methods as were used with former materials.

DUNKING AND DRYER BASKET

A NEWLY patented dunking and dryer basket, made entirely from scrap metal, is said to be extremely practical since it is included with a standard five-gallon steel shipping pail with a removable top containing the Curran Corporation's newly announced Carbon Met substitute for Carbon Tetrachloride.

The bench kit is shipped complete and is easy to use—all that is necessary is to place the part to be cleaned in the dunking basket and dip it into the volatile Carbon Met.

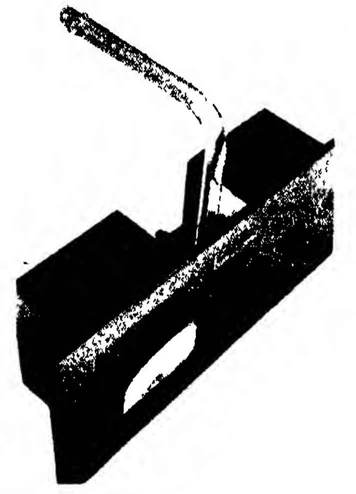
Cleaning kit, complete with cleaner

On withdrawing the dunking basket, the spring-like clips attach themselves to the edge of the container, allowing excess solvent to drain back into the pail. Within a very few minutes the parts in the basket are completely dry and clean

Since the dunking and dryer basket is constructed entirely from extra pieces and scraps of new metal, it is not necessary to have a high priority

CONTINUOUS COLOR READINGS

DESIGNED to register the light transmission of a liquid passing continuously through the instrument, a new colorimeter has been developed by the Photovolt Corporation. With this instrument



For measuring liquid colors

the concentration, color, or turbidity of a flowing liquid is read in terms of light transmission.

The operating principle of the colorimeter depends upon light from an incandescent lamp passing through a color filter and then through the liquid. The transmitted light impinges upon a photoelectric cell, the current of which then registers on an electric indicating instrument.

The distinctive feature of the Continuous-Flow Colorimeter lies in the liquid

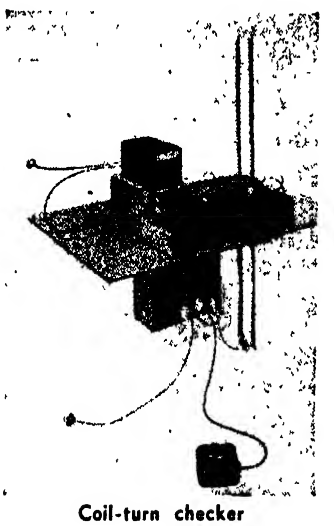
under test passing through a glass tube rather than being contained in an absorption cell or a test tube. This makes the instrument suitable for the continuous control of chemical processes in which the color or turbidity of a liquid must be checked either as a measure of its concentration or as an indication of some other chemical or physical condition. Once calibrated by means of a solution of known concentration, the instrument indicates the concentration directly and continuously, obviating the necessity of taking samples and analyzing them at regular intervals.

POLISHING POWDER

Glass, marble, and granite formerly polished with tin oxide putty powder can now be worked with a new metallic oxide powder, which does not stain, is lighter in weight than tin oxide, and is not made from highly critical materials. This new material is called Victory Fas-polish.

PRECISION TURN COUNTER

An improved coil-turn counter for laboratory or factory use in determining with precision the number of turns in wound electric coils has been announced by the Special Products section of the General Electric Company. The counter is capable of checking or determining



Coil-turn checker

the effective turns of coils ranging from 1 to 11,110 turns, at a rate of from 80 to 100 coils of like specifications per hour.

In addition to the magnetizing current control box, the new coil-turn counter comprises a portable light-beam galvanometer, two yoked test rods, a galvanometer control panel, and a foot-operated switch—all conveniently assembled for operation on table or bench.

The operation of the counter is simple. The coil to be tested is placed over the test rod and connected to test clips. The dials on the galvanometer control panel are set to the number of turns the coil should have, and the foot switch is pressed. If the galvanometer dial shows a deflection, the dial readings are increased or decreased until the deflection is zero. The dial reading is then the number of turns. When the probable number of turns in a coil is not known, a trial reading is taken and the dial is adjusted until the reading is zero on the galvanometer.

The accuracy of the counter is one turn in a thousand for coils having air cores at least ⅝ inch in diameter, an outside diameter of eight inches and less, a coil build-up to 2⅝ inches, and up to six inches in height. Accuracy is not as high for coils outside these limits.

SPRING MAT

A spring cushion device of all-metal construction, consisting of a cap, a stud or base, and a spring, is being used to provide effective spring action wherever cushioning is required. The parts of the

End and top views of spring mat

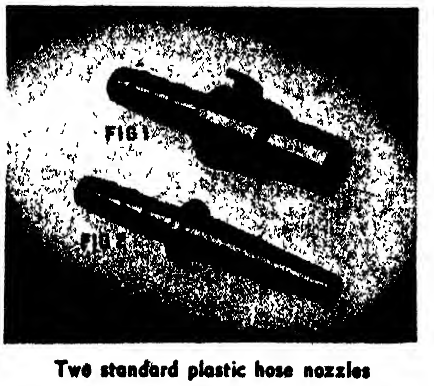
device are held together by side lips which position the springs firmly yet permit a full-floating action at all times. The construction is such as to allow free motion of the springs yet to prevent all side-sway.

A standard unit of nine cells, capable of sustaining a load of 100 pounds, can be used in any number and combination to attain the cushioning area and strength required.

For absorbing vibration and mechanical shock in machine tools, printing presses, and other mechanical installations, these Rande Unit-Springs are being used to replace rubber and other vibration absorption materials.

PLASTIC NOZZLE

One more example of the replacement of critical metals by plastics is in the field of fire-fighting equipment where strong, durable, and light plastic nozzles are now being furnished for standard hose sizes of fire extinguishers, pressure operated tanks, stirrup pumps, and so on.



Two standard plastic hose nozzles

These nozzles, produced by American Molded Products Company, have long life qualities and are corrosion proof, non-denting, highly resistant to acids, alkalis, and other liquids, and will hold their shape perfectly under normal use.

BENCH BINS

DESIGNED for use directly on the bench and without the need for racks or other holders, a series of standard bench bins are being made available by the Gordon L. Hall Company. The bins are raised at the back, thus ensuring proper forward tilt for gravity feed of small parts. These

With and without hoppers

bins, adaptable to an unlimited variety of arrangement, have folded edges at the front to protect the users' hands and are ruggedly built of sheet metal. Standard models are available as well as models equipped with hoppers, as shown.

MASKING PAPER

STRIPS of pressure-sealing adhesive applied to one or both edges of a new masking paper secure the paper to flat surfaces or protruding parts which have to be masked against paint spray. The paper itself resists paint and the adhesive strips off clean after painting is completed. The use of this Edge-Gummed masking paper shows marked economy and increases ease of removal.

TUBE MACHINE

A WIDE range of sizes of ferrous and non-ferrous tubes can be flared, squared, burred, or beaded in a new machine recently placed on the market by Leonard Precision Products Company. In this machine, illustrated in these columns, a

Levers control the tube machine

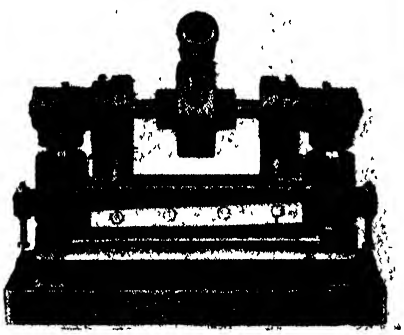
work-holder was located in front of a rotating spindle which carries an adjustable tool-holding socket. In the socket can be placed a combination burring and squaring cutter, a flaring tool, or a beading device. Arrangement is made for positioning the tube for accurate operation.

CHECK VALVE

SIX basic combinations of check valves are available with a new universal check valve recently developed for aircraft hydraulic lines, but adaptable to other purposes. These combinations are made possible by the use of a standard body and three types of adapters. By reversing the plastic poppet in the check valve assembly, the direction of fluid flow can be changed, making a total of 12 possible valve combinations.

SHEAR

AN IMPROVED bench shear for precision work on light and medium weight metals, shown in the accompanying illustration, has recently been added to the Di-Acro line. This shear, ruggedly constructed for



Front view of bench shear

long life and ease of operation, can be quickly arranged for shearing, squaring, slitting, stripping, or notching to extremely close tolerances. The use of this tool frequently eliminates the preparation expense and time delay of preparing blanking and forming dies.

RELAY

DESIGNED particularly for aircraft power circuits, a new Ward Leonard relay will perform its functions under high values of acceleration of gravity and under severe conditions of vibration and shock. Under these conditions the armature and the contact assembly will retain operating position. These functional factors have been achieved through compact and sturdy design and through rigidity of the entire relay assembly.

• • •

READERS desiring further information on new products, or research and development work reported in these pages, will be referred to manufacturers or additional sources upon request. Address our Research Department, giving specific references, including date of issue and page number.—*The Editor.*

Pre-Flight Training

Economy of Both Time and Money are Achieved With Trainer that Gives Complete Illusion of Flight

ALEXANDER KLEMIN
Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University

THE Soulé-Rabkin pre-flight trainer bids fair to speed-up and even improve the process of training young pilots. The student enters the trainer, closes the hatch, fastens his belt, and achieves the illusion of being in a flying airplane. This illusion is achieved by a combination of effects. A moving picture on a screen close ahead of the young man gives the impression of movement. As he moves the controls, the airplane nose mounted in the screen inclines in such fashion that the student can readily imagine that he is executing a bank or a turn, is climbing or descending. On the instrument panel, the instruments automatically register the true character of the maneuver. Thus the turn indicator shows the direction of the turn, the degree indicator shows the degree of the turn, the bank indicator tells the would-be pilot whether he is coordinating rudder and aileron correctly. The rate of climb indicator, the air speed indicator and the tachometer or revolution counter all register precisely as they do in a plane. A motor sound effect trains the ear and heightens the illusion of movement.

Complete illusion of flight

The "mistake counter" is still another valuable aid in this training system. Suppose the turn is made incorrectly and the ball indicator shows a skid or a side slip. The mistake counter will record the error, though a time relay gives the student three seconds in which to correct the error. By keeping a chart of the mistakes from lesson to lesson, the rate of improvement can be noted.

Then, too, there are other valuable features in the trainer, such as interchangeable noses which accustom the student to the different silhouettes of trainer, advanced trainer, fighter, and bomber. Also, the scenic strip can be changed so as to familiarize the pilot with any particular area.

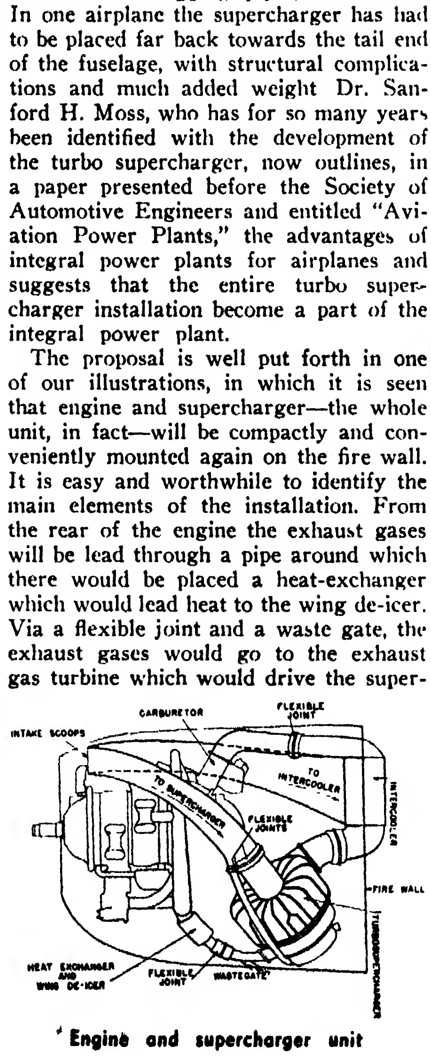
Both economy of equipment and time are provided by the new device and, in some respects, the pre-flight trainer is actually an improvement on the training plane itself. Of course, however, nobody could possibly learn to fly well without actual hours and hours of experience in the air.

• • •

INTEGRAL SUPERCHARGER
Can Overcome Many Airplane Power Plant Difficulties

IN THE installation of the supercharger there are apt to be many lengthy duct connections, difficulties in the intercoolers, difficulties in lagging pipes, and so on. In one airplane the supercharger has had to be placed far back towards the tail end of the fuselage, with structural complications and much added weight. Dr. Sanford H. Moss, who has for so many years been identified with the development of the turbo supercharger, now outlines, in a paper presented before the Society of Automotive Engineers and entitled "Aviation Power Plants," the advantages of integral power plants for airplanes and suggests that the entire turbo supercharger installation become a part of the integral power plant.

The proposal is well put forth in one of our illustrations, in which it is seen that engine and supercharger—the whole unit, in fact—will be compactly and conveniently mounted again on the fire wall. It is easy and worthwhile to identify the main elements of the installation. From the rear of the engine the exhaust gases will be lead through a pipe around which there would be placed a heat-exchanger which would lead heat to the wing de-icer. Via a flexible joint and a waste gate, the exhaust gases would go to the exhaust gas turbine which would drive the super-



Engine and supercharger unit

charger proper. The intake scoop would lead air into the supercharger. Since during the compression process the air would heat up, it would then pass through an intercooler where outside air would reduce the temperature to reasonable levels. The cooled air would then go to the carburetor and subsequently to the engine manifold.

It would be a decided advantage for the airplane designer and constructor if he could indeed secure an integral supercharged power plant and avoid all the "headaches" of designing a complete installation himself.—*A.K.*

POST-WAR

Aviation Will Not Need Government Interference

WHEN the end to the war and allied victory come, peace-time aviation will be resumed with renewed vigor; it is thus desirable to turn briefly to considerations of post-war aviation. No one can speak with more authority of America's aviation tomorrow than Colonel Edgar S. Gorrell, distinguished flying officer in the last war, and now president of the Air Transport Association.

One of Colonel Gorrell's first points in an address presented before the Foreign Commerce Club was that while aviation is a new industry, its development does not call for extraordinary social measures, for mumbo-jumbo, for "statization." Aviation did remarkably well in the hands of the pioneers and is doing well with the airlines of today. There is not the slightest necessity for government ownership either in domestic or in foreign commerce. Readers will recall the sad days when the Army took over the carrying of the mails. Direct governmental intervention or ownership has been familiar in Europe for many years, yet European airlines have lagged far behind our own, in mileage flown, in the number of passengers carried, in the speed and safety of operations. The very significant index of passenger miles per route mile operated was, in 1938, four or more times better for American air carriers than for government supported or owned European airlines.

The private airlines have now accumulated a vast degree of skill and tradition. They have *esprit de corps* and the stimulus of competition. Why should we throw all this away to let the lethargic bureaucratic spirit intervene?

We do not quote Col. Gorrell directly, but paraphrase freely and perhaps our remarks are even stronger than those of the speaker himself.

Besides advocating freedom from government ownership, the speaker drew attention to one very important bill now pending before Congress; namely, the Lea-Bailey Bill by which it is proposed that federal regulation be extended to all air commerce whether between points within a single state or between points in different states. It will be a sad day for the United States when our great states become insignificant appendages to Washington, but federal regulation of

scheduled air flying seems highly desirable. Said the speaker: "The reason is to be found in the special characteristics of air commerce. The speed of an airplane, even were it to move no faster than surface vehicles, would be much greater than the speed of surface transportation because it is able to move directly to its destination unimpeded by surface barriers. And bear in mind that even the pre-war airplane moved at a rate often five or six times faster than ordinary surface transportation."

A strong aviation industry in peace time would also mean a strong manufacturing industry, invaluable in time of war and the best safeguard against more vagaries on the part of Germany.—*A.K.*

MODIFICATION CENTERS

Perfect Aircraft Changes With Minimum Production Delay

IN THE last war and in the present war, every military aviation unit tried or tries to modernize its planes, to keep them supplied with up-to-date instruments, to introduce as rapidly as possible the changes which actual combat have shown to be necessary, to make the adjustments which a change in season or a change in climate make advisable. It remained for the American Army Air Forces to carry this principle to its logical conclusion and to provide gigantic modification centers (another name for modernization centers) all over the world.

The great advantage of these modification centers is that the airplane manufacturer can proceed with quantity production, on well planned, well organized lines, while the modification center can carry out minor work with a minimum of trouble and delay.

The service manager of one of these modification centers states the guiding principle in words upon which we cannot improve: "Production methods would require planning and tooling for 18 months to two years to build perhaps 300 ships for a special purpose. We can modify the same number of basic airframes in a fraction of that time. . . . We'll say it would take a month to make a certain die. We can beat out enough parts to do the job in a week, without slowing basic production or making it wait for change-orders." Incidentally, change orders used to be the bane of aircraft constructors.—*A.K.*

LIFE RAFT

Automatically Ejected From Forced-Down Plane

THE UTMOST ingenuity is being exercised to save the lives of airplane pilots, whether carrier-based or land-based, who may be forced down at sea. The latest and not least important device is an automatically ejected and automatically inflated life raft.

The new device, originated by engineers of Walter Kidde and Company, employs a water-sensitive switch which is mounted on the underside of the fuselage. When the fuselage of the land plane

Compressed gas does the job

touches water, release valves on two cylinders of carbon dioxide are opened automatically. The gas from the first of these cylinders opens the hatches of the raft compartments in the top of the fuselage. Gas from the second cylinder expands to 450 times its stored volume and inflates the raft which then floats free except that it is held to the plane by a light line.—*A.K.*

AUTOMATIC RIVETING

Speeds Production of Wing Spars and Skin Coverings

IN THE construction of all-metal combat aircraft, production speed is governed by the fact that thousands of rivets have to be inserted in their respective holes and driven home. To increase this speed, an automatic riveting machine, developed by General Engineering Company and illustrated in one of our photographs, provides for the mechanized riveting of wing spars or wing skin coverings.

The parts to be riveted are placed on light handling frames or run through the machine automatically on simple roll stands. Powerful hydraulic cylinders are provided, having a maximum force of 56,000 pounds. Bucking units are mounted on the upper frame, riveting units on the lower frame and the two units move together.

Actual tests has proved that the use of this machine results in savings in man power as high as 30 to 1.—*A.K.*

Aircraft riveting speeded-up

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with the names of available books, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for. Books listed in these columns may be ordered from our Book Department. Add 25 cents per book for mailing outside U. S.

Conducted by JOHN P. CANDIA

FOOD FOR THOUGHT
By Willkie and Kolachov

ONE of the most controversial subjects in the whole broad field of internal combustion engines and their use is that of gasoline *versus* alcohol. Here is one side of the question, prepared by two men who are thoroughly conversant with the art of alcohol distillation, and presented as a solution to many of the phases of the agricultural problem. One-sided though the discussion must necessarily be, it is thoroughgoing in all its ramifications. (210 pages, 6½ by 9½ inches, a number of charts, photographs, and tabulations.)—$2.10 postpaid.—*A.P.P.*

PSYCHOLOGY OF MILITARY LEADERSHIP
By Pennington, Hough, Case

AN ASSISTANT professor of psychology, a lieutenant colonel in the United States army, and an assistant manager of engineering personnel in an aircraft plant have collaborated in the preparation of this book aimed particularly at army officers who are especially concerned with the solution of military problems pertaining to the human element. The text covers the role of officers as instructors, as learners, as leaders, as disciplinarians, and as personnel technicians. It also deals with adjustment to military service, the relationship between the officer and his men in battle, and with the whole general subject of army morale. (288 pages, 6½ by 9½ inches, a few charts and tables.)—$3.10 postpaid.—*J.P C.*

PRACTICAL ESSENTIALS OF PRE-TRAINING NAVIGATION
By Skilling and Richardson

SMALL paper-bound volume. It covers celestial navigation, meteorology, map projection. (113 pages, 5½ by 8½ inches, 19 illustrations.)—$.80 postpaid.—*A.G.I.*

PRINCIPLES OF AERONAUTICAL RADIO ENGINEERING
By P. C. Sandretto

RADIO use in aeronautical navigation and communication brings into play special factors which must be mastered by those who would become proficient in this phase of radio science. The present text covers the special performance, installation, and servicing factors which are essential to the problems in hand, and outlines engineering fundamentals and methods which have been developed. The text covers: Avigation, including the radio range, direction finders, markers, instrument landings, altimeters; and communications, including medium and ultra-high-frequency operation. A section of the book is devoted to a discussion of accessories and an appendix lists mechanical requirements for aircraft radio equipment. (414 pages, 6½ by 9½ inches, over 200 drawings and photographs.)—$3.60 postpaid.—*A.P.P.*

AMERICAN DIESEL ENGINES
By E. F. Goad

A PRACTICAL text for the vocational student and the mechanic, the present book is the result of a need felt by a teacher of Diesel engine science. The fundamentals are clearly explained and exemplified by drawings and photographs of standard American Diesels. (313 pages, 6½ by 9½ inches, over 100 illustrations.)—$2.85 postpaid.—*J.P.C.*

SEMIMICRO QUALITATIVE ANALYSIS
By Arthur R. Middleton and John W. Willard

THIS chemical teaching text sets forth modern methods for qualitative analysis using small amounts of samples and reagents for speed and economy. The two parts of the book, approximately equal in size, discuss basic theory of chemical reactions with suitable problems, and laboratory technique of analysis, respectively. (266 pages, 6 by 9 inches.)—$3.85 postpaid.—*D.H.K.*

NEWPORT TOWER
By Philip Ainsworth Means

MOST enigmatic, provocative building in the United States is the noted old round stone tower at Newport—subject of an unbelievable amount of altercation, some of it bitter. Was it only a colonial windmill or, as this archeologist writer attempts to prove, the church of a lost 12th, 13th, and 14th Century colony of Norsemen? The author organizes his

The Editors Recommend

Best Sellers in Science

PLASTICS — *By J. H. Dubois.* Meaty information on the whole general subject of plastics, presented in narrative form for easy reading. Tabulations of properties of plastics, plus basic design information, for laymen and technicians alike. $3.10

EXPERIMENTAL ELECTRONICS — *By Ralph H. Muller, R. L. Garman, and M. E. Droz.* A solid book of eminently practical information on the characteristics and non-communication applications of electron tubes. The text describes experiments and presents results. For students, radio engineers, communications experts, and the serious general reader. $4.75

HOW TO READ ELECTRICAL BLUEPRINTS — *By Gilbert M. Heine and Carl H. Dunlap.* A chapter on how blueprints are made, plus nine other sections, each of which is devoted to a specialized part of the electrical field, from bell and signal wiring through motor control diagrams to power station blueprints. $3.10

GET TOUGH! — *By Capt. W. E. Fairbairn.* How-to-win-in-hand-to-hand-fighting directions, by a man who really knows rough-and-tumble methods that are *not* "clean" fighting but *are* designed to win. $1.10

A COMPREHENSIVE SMALL ARMS MANUAL — *By Charles T. Haven.* Prepared to acquaint State Guards, Regular Police Depts., Coast Guard Auxiliaries, Plant Guards, Auxiliary Police Depts., and civilians with the operation, care, and limitations of weapons at present available for these types of defense and protective units. Discussion of all types of military and sporting rifles, shotguns, submachine guns pistols, and revolvers, as well as their care, use, and ammunition. $1.60

TECHNIQUE OF PLYWOOD — *By Charles B. Norris.* Technical information on all phases of plywood manufacture and use, compiled for engineers, designers, and users of plywood. Important to many phases of wartime housing and manufacturing problems. $2.50

FUNDAMENTALS OF RADIO — *By Jordan, Osterbrock, Pumphery, and Smeby.* With this one volume alone, and with some diligence of application, it is possible to obtain a thorough grounding in radio principles. In thoroughness of treatment, with due respect for the needs of the reader, this book is outstanding. $5.10

POPULAR MATHEMATICS—*By Denning Miller.* Anodyne for those who have mathematical indigestion. Ground treated is arithmetic, geometry, algebra, analytical geometry, trigonometry, conic sections, solid geometry spherical trigonometry, calculus. The coverage is not complete; it is rather, a collateral book—and good friend. $3.85

ELEMENTS OF ORDNANCE — A textbook prepared for cadets of the United States Military Academy. Covers manufacture, the chemistry of explosives, types of weapons, mathematics of ballistics, etc. $6.60

AIRCRAFT INSTRUMENTS — *By George Ellis Irvin.* All types of instruments for aircraft use described for students, pilots, inspectors. Fundamentals, instructions. $5.10

MARINE DIESEL HANDBOOK — *By Louis R. Ford, M.A.* A compendium of data on design, construction, and operation of the marine Diesel engine with chapters covering applications, principles, types, fuel injection systems, lubrication, supercharging, and so on. $7.25

MACHINERY'S HANDBOOK—*Eleventh Edition.* "Bible of the mechanical industry," enlarged to 1815 pages of latest standards, data, and information required daily in the shop and drafting room. $6.10

PROCEDURES IN EXPERIMENTAL PHYSICS — *By John Strong, Ph.D.* A wealth of useful data of a practical kind for the constructor, experimenter, and skilled craftsman. $6.80

STEEL SQUARE POCKET BOOK — *By Dwight L. Stoddard.* Practical methods of using the carpenter's steel square for layout work of all kinds. Time-tried methods used by two generations of carpenters and found both rapid and accurate. $1.00

NORTON'S STAR ATLAS AND TELESCOPIC HANDBOOK — *By Norton and Inglis.* An old standby and most commonly used atlas for telescopes without setting circles. 18 maps and 65 pages of compact notes and tables. $5.00

WORKING WITH THE MICROSCOPE — *By Julian D. Corrington.* For the serious beginner. Explicit, practical. $3.60

TOOL MAKING — *By C. B. Cole.* Instructions for making and using all kinds, from personal tools to arbor presses, lathes, planers, etc., in different metals. $3.60

THE ELECTRON MICROSCOPE — *By Burton and Kohl.* A well-written account of this newest tool of science, with all technicalities explained for complete understanding by average persons. $3.95

ENCYCLOPEDIA OF KNOTS AND FANCY ROPE WORK — *By Granmont and Hensel.* More knots are described in this remarkable book than in any book on seamanship ever published or dreamed of. 3257 knots are illustrated in half-tone reproduction and are described in the text. $5.10

A MATHEMATICS REFRESHER — *By A. Hooper.* Prepared mainly to refresh aviation trainees whose high school mathematics is rusty. Scope — arithmetic through calculus. $2.60

PLASTICS, PROBLEMS AND PROCESSES — *By Mansperger and Pepper.* The whole story of plastics, including a resume of manufacturing processes and a number of thorough-going chapters devoted to plastic uses. $3.10

AUTOMATIC ARMS — *By Melvin M. Johnson and Charles T. Haven.* Comprehensively covers machine guns, machine rifles, sub-machine guns, pocket pistols, shotguns, sporting, military rifles in automatic classification. $5.10

BASIC FIELD MANUAL, INFANTRY DRILL REGULATIONS. Practical working manual for commissioned, non-commissioned officers. $.50

HANDBOOK OF CHEMISTRY AND PHYSICS — A classic reference book recently revised and brought up-to-date to keep pace with recent research. Includes material on all branches of chemistry, physics, and allied sciences. Used in laboratories and by engineers throughout the country. Flexible binding, 2503 pages. $4.10

ATOMIC ARTILLERY — *By John Kellock Robertson.* Electrons, protons, positrons, photons, neutrons, and cosmic rays, all described for the layman in plain language. Also transmutation of the elements and the manufacture of artificial radioactivity. $2.35

● The above prices are postpaid in the United States. Add, on foreign orders, 25¢ for postage on each book, except as noted. ●

For Sale by: August, 1943

SCIENTIFIC AMERICAN, 24 West 40th Street, New York 18, N. Y.

I enclose $.... for which please forward at once the following books:

....

....

Name ....

Address ....

Write us for information on books on any subject. We can supply any book in print.

arguments and summarizes others' arguments extremely well, though without enough unemotional scientfic detachment. Essentially, this is a fascinating scientific detective story. (344 pages, 6¼ by 9¼ inches, 141 illustrations.)—$5.10 postpaid.—*A.G.I.*

SPORTS PHOTOGRAPHY
By Lee Wulff

A BRIEF, easily mastered text for sportsmen who want to achieve that thrilling action in their photography which adds so much to the finished result. An understanding of the requirements is reached without resort to obscure technicalities. (184 pages, 6½ by 9½ inches, 109 sports photographs.)—$2.60 postpaid.—*J.P.C.*

RADIO FROM START TO FINISH
By Franklin M. Reck

MISLEADING though the title of this book may be to those who are searching for a comprehensive text book, the author has traced in narrative form the progress of radio from the early work of Maxwell and Hertz through the developments made by Marconi, Fessenden, Alexanderson, and others, to broadcasting and military uses of radio as we know them today. Another error of the title: We are far from the finish of radio. (160 pages, 6½ by 9½ inches, a number of outstandingly good photographs.)—$2.10 postpaid.—*A.P.P.*

ELEMENTS OF FOOD BIOCHEMISTRY
By Peterson, Skinner, and Strong

TEXT for undergraduate courses, covering carbohydrates, fermentation food-products, acidity, lipides, proteins, mineral elements in nutrition, water, vitamins, enzymes. This is a technical, not a popular, book and it assumes familiarity with organic chemistry. (291 pages, 6 by 9 inches, 30 illustrations.)—$4.10 postpaid. —*A.G.I.*

BASIC MATHEMATICS FOR PILOTS AND FLIGHT CREWS
By Newsom and Larsen

THIS little book gives precisely the mathematics a pre-flight cadet must be able to use: Review of arithemetic, algebra, proportion and variation, graphs, mensuration, angular measure, scales, vectors, circular slide rule, trig. Problems and answers. (153 pages, 5 by 7 inches, 39 illustrations.)—$2.10 postpaid.—*J.P.C.*

TABLE TENNIS
By Jay Purves

A FORMER world's champion describes in comprehensive and concise text the fundamentals of successful table tennis. (82 pages, 6½ by 9½ inches.)—$1.10 postpaid.—*J.P.C.*

RADIO TROUBLESHOOTER'S HANDBOOK
By Alfred A. Ghirardi

NINE sections of new material have been added to this third revised edi-

tion of a book that is considered as standard by many radio service men. It covers trouble shooting, adjusting, and repairing home, portable, and auto receivers as well as automatic record changers of all types. (744 pages, 8½ by 11½ inches, a tremendous number of drawings, diagrams, and tabulations. Completely indexed.)—$5.10 postpaid.—*A.P.P.*

THE STUDY OF THE PHYSICAL WORLD

By Cheronis, Parsons, and Ronneberg

SCIENCE survey courses, for which this is a text-book, exist to give incoming college freshmen a rapid sweep of all the physical sciences. Since such courses are relatively superficial, the text-books make good reading for scientifically-inclined adults who want to make a similar sweep without too much study. This one covers a broad field. (898 pages, 6 by 9 inches, 467 illustrations.)—$3.95 postpaid. —*A.G.I.*

THE RADIO AMATEUR'S HANDBOOK—20th EDITION

ALMOST 500 text pages plus an advertising section comprise the latest edition of this well-known standard reference book in the radio field. (6½ by 9½ inches, a large number of drawings and photographs.)—$1.00 postpaid.—*A.P.P.*

ATOMS, STARS, AND NEBULAE

By Goldberg and Aller

ONE MORE of the "Harvard Books on Astronomy" which are appearing one by one and which, together, will constitute a "shelf" covering that science. This volume is an elementary astrophysics treatise, for which there has been much need. It is neither light nor too formidable for readers already familiar with treatises on elementary astronomy. (323 pages, 5¾ by 8½ inches, 151 illustrations.)—$2.60 postpaid.—*A.G.I.*

AUTOMOTIVE MECHANICS—I.

By Clarence G. Barger

WRITTEN to meet the first half of the Preinduction Training Course in Automotive Mechanics, the text of this book covers, in simplified form, types of vehicles, chassis and body, power unit, power train, and cooling system. (166 pages, 6½ by 9½ inches, over 100 illustrations.) —$1.20 postpaid.—*J.P.C.*

GEOMORPHOLOGY

By Norman E. A. Hinds

GEOMORPHOLOGY is the modern, four-dollar scare-word for simple old-fashioned physical geology—that part of geology which explains the evolution of the earth's surface, the landscape. This is an easily understood, elementary text-book treatise of the modern type (purposely interesting instead of studiously dull) from which the average reader outside of the campus can learn to interpret the earth features he sees about him. (894 pages, 5¾ by 9 inches, richly illustrated.)—$5.15 postpaid.—*A.G.I.*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

NOW AND then this department learns of a telescope mirror which, while its performance on the stars apparently is not affected, exhibits under the knife-edge the entire outline of the lap on which it was cold pressed. George A. Kennedy, mining engineer, of Denver, before he died, described a mirror figured for him by C. S. Walton, 5975 W. 44th Ave., Wheatridge, Colo. (after a very noted old optical firm in New England had re-figured it for $100 and done a botch job). The lap had often been left for many hours on the mirror, under a seven-pound weight. At the end of figuring, the Foucault test made clearly visible the pattern of the lap. "It does not seem to interfere in the least with the excellent performance of the mirror on the stars," Kennedy wrote. Yet his curiosity was aroused.

A. W. Everest commented as follows: "I've seen pitch that would etch glass, and I know of several cases where ordinary city water ate a hunk right out of it. Leo Scanlon has a mirror that looks like a perfect pitch lap under the knife-edge test, yet with a perfect visual polish. He blames it on the water in the Monongahela River. Kennedy's, however, sounds like that other monster, pitch flowing into the glass, with long pressing. Glass molecules are rather loosely packed, and pitch will readily flow in between them if the water film is missing. When the lap is removed, generally only after a fight, this pitch is sheared off and stays there, making the pattern of the lap harder than the rest of the surface. You can't see it at first, but, since this part of the surface polishes slower than the rest, about the time you think you are finished, there the thing will stand out in relief under the knife-edge test. Several hours' hard polishing would cut through this hard skin."

"Why, however," Everest continues, "does anybody press any lap more than an hour or so with only enough weight to get it into contact? The lap doesn't fit the mirror ten seconds after you start to use it, anyway." [See Everest's chapter on advanced mirror making technique, in "A.T.M.A."—Ed.]

Referred to Kennedy, these comments elicited the following: "The lap was never in contact with the glass *dry* for a moment. Also, acid etching would seem to be the most probable answer if the image on the glass were all criss-crossed, because of the numerous times the lap had been replaced in a different position during pressing and polishing. But it is not. The lines of the facets are all clear and unbroken."

This appears to eliminate the effect described by Everest, in connection with this particular mirror, but the effect, with its odd cause, is well worth remembering.

The correspondence was shown to Leo Scanlon, who passed it to Dr. Lee Devol, at the Mellon Institute of Industrial Research, who is interested in glass. He commented as follows: "Glass does many strange things which we have not yet learned how to explain. I do not believe any of us can say exactly what took place in the transfer to the glass. We do know that glass is readily attacked by different chemicals. Even pure water can be guilty of the attack. There was moisture in the lap, together with a large number of compounds whose action it would be impossible to predict. The remaining surface may be more resistant to polishing because it is harder, or because it is more resistant to chemical attack by the water in the rouge, or it may be that the chemical nature of the glass surface is such that it is less inclined to attach itself to rouge than it would have been before exposure to the lap. In this case there should be, for the portion of the glass which has been covered by the lap, a lower coefficient of friction in polishing."

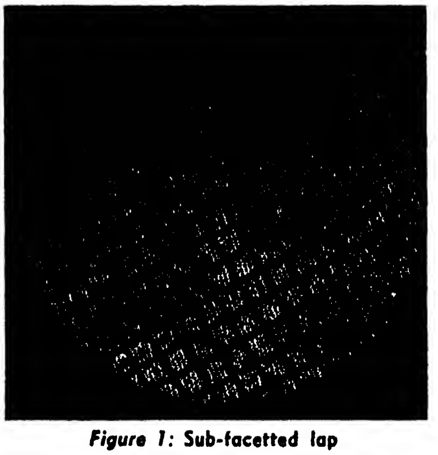


Figure 1: Sub-facetted lap

Well, so what? This: We have hypotheses but no final answer. Can anyone else provide the definitive one in this odd puzzle?

ONION SACK or any kind of coarse-mesh netting may be used for cold-pressing sub-facets, or facetettes, into the ordinary facets of a pitch lap (Figure 1). This has long been common among professionals. There is no mystery about it and it is simple to do. The fabric (wet) is laid on the pitch lap, and the mirror is then laid on the fabric, and cold pressing is done as usual.

Commenting on the use of onion sack, Cyril G. Wates, Edmonton, Alberta, says, "I wouldn't go back to the plain lap. You can lift the mirror right off the sub-facetted lap with no suction at all. The objection, sometimes heard, that the facetettes soon press out seems without much foundation. They remain after 24 hours' cold pressing (without weight). I also find them a complete remedy for the mottled effect known as 'dog biscuit.'"

F. B. Ferson, Biloxi, Miss., who also uses onion sack, says, "My experience is, as Wates says, that the facetettes take quite a long time to press out. I like facetettes from onion sack because the lap seats almost at once. I use common onion sack from a grocery store—first washing it, of course. The lap hardness and pressure of polishing govern the sinking speed of facetettes. They should sink out in not over two hours of actual work of polishing by hand."

Your scribe years ago used marquisette for the same purpose. If you don't know this word, ask the feminine side or, simpler still, yank down a window curtain (justified, of course, in the name of sacred science). Figure 1 shows a 6" lap with facetettes pressed in with some such material, as used by H. Lynn Bloxom, 1425 Fourth Ave, N., Fort Dodge, Iowa.

AS IS WELL-KNOWN, after several years' effort to teach his invention, the HCF lap, perfect manners, A. W. Everest decided that it probably would never become a true smoothie. He, therefore, revised his chapter on the HCF lap in "A.T.M." (4th ed.), recommending its use through the polishing and gross figuring stages alone, and a pitch lap for final figuring. The reason for this was the uneven surface texture HCF gives.

Others found that HCF will not always make a perfectly fitting lap: It is often rather inflexible. William A. Rhodes, 1206 E. Garfield Street, Phoenix, Ariz., obtains a perfectly fitting HCF lap by softening the beeswax tetrahedrons with radiant heat and pressing before they cool.

First, the tool is primed by rubbing pieces of HCF or other beeswax into its pits. Next, the HCF is applied, the mirror laid on it, and the protruding HCF trimmed off.

Then, with a bowl type of electric floor heater, the lap is warmed to the exact temperature "at which, by touching the very edge of the HCF with the finger, it will feel as if about to collapse, but no higher." Rhodes points out that, if carried a whisker higher, it "will suddenly disintegrate into a puddle even before one can withdraw the lamp. What is wanted is a mushy condition."

In the meantime the mirror has been warmed, and rouge mixture has been swabbed on it.

The warm mirror is placed immediately on the lap and loaded with about ten pounds extra pressure, and the two are left to cool to room temperature.

"Instead of the tetrahedrally embossed

HCF surface it will look as if buckshot had been pressed into it. This gives 50 percent added surface at the start of polishing and the surface will fit the mirror."

This, of course, is now essentially a plain beeswax lap, not an HCF lap, but many prefer beeswax laps anyway, and this is one way to make one.

Rhodes roughs out his mirrors with crushed steel and makes a separation of glass particles from the particles brushed off the tool, for re-use, by means of a magnet, which picks up the steel grains. These are then pulled off the magnet by hand.

THE FOLLOWING communication written by F. W. Bubb, Professor of Applied Mathematics at Washington University, St. Louis, Mo., appeared in the *Journal of the Optical Society of American* (Vol. 32, p. 400), and is related to the note on page 319, "Amateur Telescope Making" (Prof. R. W. Wood's experiments).

"It is well known that a liquid rotating in a vessel with constant angular velocity develops a central cavity in the form of a paraboloid of revolution. Such a liquid surface formed upon mercury was used by Professor R. W. Wood as the reflector of a telescope.

"The thought naturally comes that, if one could solidify a liquid after rotation had been set up, one might get a very perfect parabolic mirror—possibly of great size and of any desired focal length.

"A number of synthetic resins are now available in liquid form, which harden into solids upon heating. Some of these solids are remarkably strong, having a tensile strength of about 15,000 pounds per square inch.

"May it not be possible to rotate a vessel containing one of these liquids, heat it while maintaining the speed of rotation constant, and thus harden the plastic with its perfect parabolic cavity? Such a surface could then be coated with a reflecting metal film.

"Certain questions arise as to the practicality of this scheme. Would the rather high viscosity of these liquids permit the parabolic surface to form before hardening sets it? After hardening begins, does the volume of the plastic change—thus altering the shape of the surface? Will evaporation from or absorption of moisture into the body of the plastic alter the shape? Might not these objections—as well as those which others will find—be overcome?"

Your scribe referred this question to some of those in charge of the 200-inch telescope. It will be recalled that, before using glass for the mirror, a variety of other substances were carefully studied. It proved that the trouble with this idea was the "mosaic" structure that forms on the surface of the synthetic resins.

TEST for turned down edge on a mirror is offered by William M. H. Grace, Jr., 304 S. Foster St., Dotham, Ala. Place the mirror on edge on a table so that the image of a naked lamp bulb, behind the observer, appears on it. The lamp bulb should be far enough from the eye (via the mirror) to appear about one fourth the mirror's diameter. Look at the image and move the head until it shifts to the mirror's edge. If the bulb appears to flatten just before its image runs over the edge, the edge is turned down. If it appears to be sucked over the edge, the edge is turned up.

Grace finds this test more delicate than the eyepiece test—which, however, isn't nearly so sensitive, according to Harold Lower, as the Ronchi and diffraction tests, especially if the eyepiece is a cheap one. But it would show a grossly turned edge, and such a test is useful to beginners who don't yet feel sure of their own interpretation of other tests.

THERMAL effects caused by evaporation of the water used in polishing are explained by Everest in "A.T.M.A." page 27. To obviate this, J. R. Haviland suggests a trial of Prestone or a saturated solution of magnesium chloride and water —neither of which liquids will dissolve pitch or wax and, being non-volatile, will not evaporate.

SHARKS who can handle optical design, including its mathematical equations, will find in the May number of the *Journal of the Optical Society of America* a 15-page article by W. M. Stempel of Stevens Institute of Technology, entitled "An Empirical Approach to Lens Design." The design of a Huygens eyepiece is the example used for setting forth this empirical method.

HAVE you a copy of Conrady's "Applied Optics and Optical Design" which is not at present in use, and which you will be willing to place in the hands of war production workers in optics who need this book? It is now (temporarily, we hope) out of print and apparently unobtainable anywhere. You could probably obtain from sale whatever you originally paid, even for a worn copy. Other books on optics are out of print, one being Martin's "Applied Optics" which, it is said, will not be reprinted for the duration.

NEW BOOK entitled "Prism and Lens Making," by F. Twyman of Adam Hilger Ltd., England, embodies that author's lifetime experience in this work and will soon be reviewed in this magazine. It contains much that would interest precision opticians in any kind of production. (Advance notice.)

TROPICAL sky maps are not common. In an English scientific journal (*Nature*, March 27, 1943) we discover a brief listing as follows: "Watson, H. E., compiled by. The Tropical Sky; maps of the constellations visible in the latitudes of the West Indies, Guianas, Nigeria, E. Africa, Ceylon, Malaya, etc. (5° to 10° N. or thereabouts) and of the planets and Solar System, showing how and where to identify them in the starry background. Pp. 27 plus three maps. Georgetown, British Guiana, *Daily Chronicle, Ltd.*, 1942. 3s 6d. net." These maps are *not* available from Scientific American, and interested readers must order direct from the publishers. We have not seen the maps. The above are *all* the data we have concerning them.

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

DY-NAMIC BALANCING MACHINES is a loose-leaf booklet presenting condensed specifications for a line of floor and bench model machines designed for accurate balancing of rotating parts. Supplementing this material is a resume of the need for balancing certain types of mechanical equipment. *Bear Manufacturing Company, Industrial Division, Rock Island, Illinois.—Gratis.*

WOOD PRESERVATIVES is an eight-page illustrated brochure directed toward constructors of laminated beams and arches as well as manufacturers of sash, doors, plywood, and other wood products. The text explains the advantages of a complete series of low-cost wood treatments for protecting against moisture and fungi decay. *I. F. Laucks, Inc., 911 Western Avenue, Seattle, Washington.—Gratis.*

HANDBOOK ON EDUCATION AND THE WAR is a 359-page book reporting statements made by heads of Federal war agencies which are concerned with education and symposiums held on 26 of the more acute wartime educational problems. *Superintendent of Documents, Washington, D. C. —55 cents.*

THE STORY OF LIGHTNING, a 24-page booklet, is an account of how "thunderbolt hunters" study and counterfeit lightning in order to help improve electric service. Photographs of the equipment and of actual flashes of lightning are included. Bulletin GEB-124, *Publicity Department, General Electric Company, Schenectady, New York.—Gratis.*

LADY, WILL YOU GIVE A LIFT? is an illustrated manual designed to provide a short cut method for teaching women to operate industrial power trucks. In it the prospective operator is told how to run the truck, given pointers on how it should be cared for, and impressed with the importance of her job. *Elwell-Parker Electric Company, Cleveland, Ohio.—Gratis.*

UNICHROME ALKALINE COPPER PROCESSES is a pocket size folder which describes a process of depositing copper with an unusually fine-grained, homogeneous structure, and with good adherence and smoothness. Advantages and applications of this copper plating method are briefly described. *United Chromium, Incorporated, 51 East 42nd Street, New York, New York.—Gratis.*

MACHINING COPPER AND COPPER BASE ALLOYS is a 32-page booklet which presents condensed data on basic machining operations, including tool rakes and clearances as well as cutting speeds and feeds. Additional tabulations give physical constants, theoretical rod weights, and standard specifications for copper and copper alloy rods. *American Brass Company, P. O. Box 790, Waterbury, Connecticut. —Gratis.*

SHALL RESEARCH BE SOCIALIZED? is a 22-page analysis of the Kilgore bill, S. 702, entitled "a bill to mobilize the scientific and technical resources of the nation, to establish an office of Scientific and Technical Mobilization, and for other purposes." *National Association of Manufacturers, 14 West 49th Street, New York, New York.—Gratis.*

HOW TO MAKE YOUR SAFETY EQUIPMENT LAST LONGER is a 32-page illustrated handbook covering all types of personal protective industrial equipment. Practical "do's and don'ts" serve as a guide for instruction of equipment users. *Mine Safety Appliances Company, Braddock, Thomas, and Meade Streets, Pittsburgh, Pennsylvania.—Gratis.*

ENGINE DESIGN AS RELATED TO AIRPLANE POWER is an 80-page lavishly illustrated booklet which attempts to acquaint the average person with a few of the problems involved in the design of military aircraft. Special emphasis is placed on engines and supercharging equipment. *General Motors Corporation, Detroit, Michigan.—Gratis.*

PEDIGREE INSULATING VARNISHES is a 36-page illustrated booklet describing the production of these varnishes and giving brief summaries of their uses. A tabulation lists a number of coatings for specific applications. *The P. D. George Company, Saint Louis, Missouri.—Gratis.*

COLLOIDAL GRAPHITE is a 12-page folder which gives a most complete and up-to-date story of colloidal graphite and its usefulness to industry through application of its lubricating and other desirable properties. *Acheson Colloids Corporation, Port Huron, Michigan.—Gratis.*

AUTOMATIC TUBE-ICE MACHINE is a 16-page illustrated booklet which describes a modern method of producing sized ice for refrigerating purposes in the food processing, food catering, and industrial fields. *Henry Vogt Machine Company, Louisville, Kentucky.—Gratis.*

LAMINATED ARCHES AND BEAMS is a 12-page illustrated catalog describing these types of units for a wide variety of structural purposes. *Unit Structures, Inc., Peshtigo, Wisconsin.—Gratis to constructors, engineers, architects, and draftsmen.*

GRAIN SIZE IN TIN ALLOYS is a technical paper throwing interesting light on the part played by grain size in the physical properties of pure tin and its alloys. *Tin Research Institute, Fraser Road, Greenford, Middlesex, England.—Gratis.*

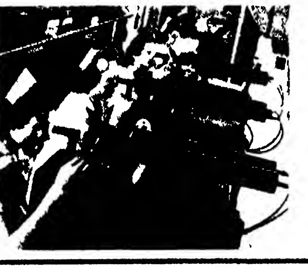
THE REDESIGNED 40-MM. ANTI-AIRCRAFT GUN CARRIAGE, by Dr. John L. Miller, is a technical report of the application of welding to this specific wartime job. A number of interesting tabulations and comparison photographs are presented. *James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.—Gratis.*

Printed in the U. S. A. Press of the Wilson H. Lee Company, Orange, Connecticut.

Scientific American

Founded 1845

CONTENTS • SEPTEMBER 1943



THE "machine guns" shown in the illustration on our front cover are actually collimators used in checking binoculars for sharpness and definition of image as well as for testing optical alinement. Precipitrons — electric air cleaners— protect the equipment from dust, lint, and other air-borne dirt particles. The girl inspectors even shun face powder lest a flake obstruct part of an optical system. Photo by Westinghouse.

SCIENTIFIC AMERICAN, September, 1943 Vol. 169, No 3 Owned and published by Munn & Co., Inc , Orson D Munn, President· I Sheldon Tilney, Vice-President; John P Davis, Secretary-Treasurer; A P. Peck, Assistant Secretary; all at 24 West 40th Street, New York 18, N. Y Entered at the New York, New York, Post Office as second class matter June 28, 1879, under the act of March 3, 1879. Additional entry at Orange, Connecticut. Published monthly by Munn & Co., Inc., 24 West 40th Street, New York 18, N Y Files in all large libraries; articles are indexed in all leading indices. Subscription rate $4 00 per year. Canada and foreign $5.00

Previews of the Industrial Horizon

A. P. Peck

HEAT WITHOUT HEAT

INDICATIVE of the many ways in which the science of electronics is invading industry is the article on electrostatic and electromagnetic heating on page 103. Starting as a laboratory stunt only a few years ago, electronic heating is now speeding many processes involving both metals and non-metallic materials. Despite its high cost, compared with other heating methods, electronic heating is finding more and more applications where its advantages outweigh its cost. When heat must be closely confined to a limited area, when parts to be heated are relatively inaccessible, and in many other instances, electronic heating comes to the fore. It will blossom to an even greater extent when consumer-goods manufacture once more gets underway and the lessons that have been learned in war-time production are turned to pursuits of peace.

WHERE MASS IS IN MOTION

OPTIMISTIC indeed is the post-war outlook for aluminum and magnesium and alloys employing these two light metals. With a projected production of over a million tons of aluminum annually by the end of 1943, and correspondingly large amounts of magnesium, there will be productive capacity available that will bring aluminum into poundage competition with copper, and not too far behind iron and steel, when all phases of the situation are considered. Watch uses of aluminum and magnesium zoom, particularly for vehicles where physical masses have to be moved by horsepower, as well as in building construction and the electrical industry. Peace-time applications of the light metals will even surpass many of the present optimistic predictions.

STEEL IS NOT ASLEEP

REGARDLESS of the advantages that light metals hold in many applications, let there be no thought that they are going to capture markets from older materials without a struggle. Steel, for example, is just as alive to post-war possibilities as the light-metal industry and is busy planning for the future. Alloy steels are being developed today far beyond the wildest dreams of only a few years ago. These alloys, tailored to measure for special jobs, will find uses from which they cannot be dislodged. The final balance in the metals field (as far as it can be reached this side of Utopia), will find each metal in its best place, with the ultimate consumer as the greatest beneficiary of research.

A SKIN-DEEP METAL

ANOTHER phase of the metals situation, which will have far-reaching effects in the machine-tool industry as well as in other lines where hard surfaces are needed for one reason or another, concerns the rapidly expanding uses of industrial chromium plating. See page 112 for details. Boring and milling tools, cylinders and pistons, bearings and dies are all feeling the impact of the development of the hard, smooth surface made possible by a plating of chromium. The results so far indicate possibilities for the future that will embrace many metal fields where plating has never before been used.

CHEMICAL RUBBER

NO MATTER which side of the picture is looked at, the tremendous development of the synthetic rubbers is going to have a lot to do with consumer goods in post-war days. An idea of the vast possibilities of man-made rubbers may be gleaned from the article starting on page 115. That the work which has been done so far, and which will result in an installed capacity in excess of prewar natural rubber consumption, will have its effect on natural rubber production in the future is a fact that cannot be overlooked. The properties of some of the synthetics are such that they cannot only replace natural rubber in many uses but can do a better job in certain respects.

NATURAL RUBBER

SOME POST-WAR planners in the rubber field are advocating a return to the importation of natural rubber from its former sources and the development of new natural sources in the Western Hemisphere. Arguments are usually based on matters involving wages and standards of living in the areas of rubber production. This, of course, brings into the picture comparative costs of synthetic and natural rubbers and poses questions which only time can answer Incidentally, rubber from guayule, golden-rod, and so on appears slated to remain in the experimental stage for some time to come. Synthetic rubber sources have been developed more rapidly than nature can produce rubber in these plants; hence synthetic has become *the* rubber of (at least) the duration.

TRANSOCEANIC FLIGHT

IF AND WHEN the Armstrong Seadromes (see page 118) provide stepping stones across the Atlantic, some ideas about transoceanic flight will have to be revised. The flying boats of the present are designed for long flights with large loads of fuel; the planes which use the Seadromes will be landplanes and need not be burdened with as much weight in gasoline. Greater pay loads will be possible when the oceanic stepping stones are available, and the air transport industry will be able to compete on a more stable basis with other forms of transportation.

In the same vein there must be considered the possibilities of glider trains for transoceanic freight and express. The epic flight of a towed glider across the Atlantic, announced early in July, has already blazed another aerial trail. Coupled with recently developed methods of picking up gliders from the ground while the towing plane is in flight, this aerial transportation system holds possibilities limited only by the resourcefulness of engineers in the aircraft industry

MORE NEWS ABOUT PLASTICS

NYLON has gone all-out for war, as the ladies of the nation know only too well. All of this synthetic material now goes into parachutes, tire cords, and other military requirements. As with many other products, however, research continues apace and now it appears that the basic nylon will find unusual applications in the plastics field after the war.

With the highest softening point and the greatest toughness of any of the thermoplastics, nylon plastic promises to overcome many of the disadvantages of thermosetting plastics while retaining their advantages. The previous upper limit at which thermoplastic materials will soften has been about 280 degrees, Fahrenheit; nylon will not soften until heated to 450 degrees.

Other properties of nylon plastic that will be found useful in post-war design include extreme toughness even in thin

(Please turn to page 135)

50 Years Ago in . . .

Condensed from Issues of September, 1893

ALUMINUM—"A new process for obtaining aluminum from its oxide includes chemical combinations heretofore supposed to be impossible. . . . The discoverer of this process and his Duluth associates say they can produce pure aluminum at a price considerably below that of any of the electrical processes, and cheaper, bulk for bulk, than copper. The native clay is useless. In fact, the only available mineral for the purpose is bauxite, which is an impure oxide of aluminum."

GAS POWER—"For a given tank capacity and with carbonic acid and air stored at the same pressure, the (liquefied) carbonic acid is capable of developing four to five times more power than compressed air."

EARLIEST MAN—"Scientific men are agreed that the human race did in some way arise from some inferior animal form—not necessarily monkeys. The transition may not have been gradual, but abrupt—evolution per saltum. We do not find the 'missing link'; it is still missing; it may be forever missing."

CORINTH CANAL—"The Corinth ship canal, connecting the Gulf of Lepanto with the Aegean Sea, was formally opened on July 29. . . . The canal is three and nine-tenths miles long and the minimum depth is 25 feet, while the average breadth is 100 feet. A bridge crosses the canal about a mile from the west end and is 230 feet above the water level, so that vessels can pass freely."

DUST ENGINE—"A novel motive power engine has been invented, based upon the fact that very finely divided carbon, floating in the air, readily explodes, and to adapt this to the generation of motive power the inventor proposes to grind coal to an impalpable powder, and, after introducing the dust floating in the air into the cylnder of an engine, explode it, the idea being to follow very much the same lines which are being so thoroughly developed in the use of gas in engine practice."

SAFE FARMING—"Secretary Morton reminds the croakers that only about 3 per cent of all the merchants escape failure, whereas hardly 3 per cent of the farmers fail. The statistics really show that agriculture is safer than banking, manufacturing, or railroading, taking all things into account"

TIN—"At the tin mines of the Maliwun Peninsula in the Mergui in the extreme south of Burma, there are two tin smelting houses, where during the smelting season seven hundredweight of tin can be smelted in a day by each furnace with four or five men."

WORLD'S FAIR—"Such a profusion of electric lights as one sees in the buildings and on the grounds of the World's Fair has probably never been viewed by mortal man before. . . . Arc and incandescent lamps are everywhere. The white buildings reflect the lights and make the scene as bright as day. On those nights when every lamp is burning, the electric fountains playing, and fireworks are shooting up from the lake, the scene is almost beyond description."

DECIMAL POINT—"In both France and Germany one-fourth (¼) reduced to a decimal is written as 0,25; in England it is written 0·25 (always with the period at the top of the line), and in the United States in this way, 0.25."

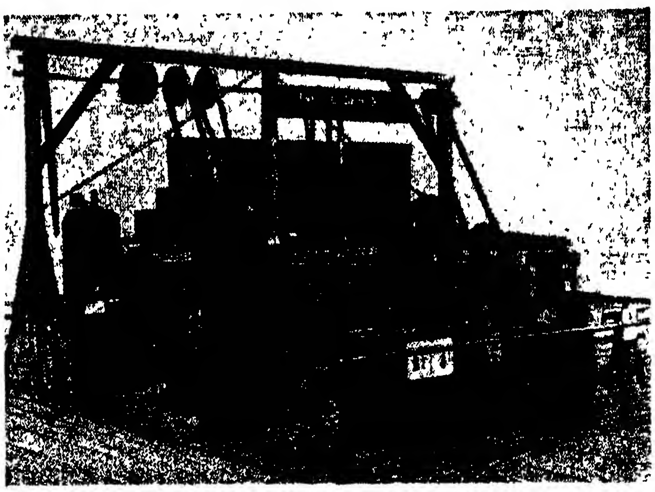
RIFLES—"Breech-loading rifles were invented in 1811, but did not come into general use for many years. It is estimated that over 12,000,000 are now in actual service in the European armies, while 3,000,000 are reserved in the arsenals for emergencies."

SWEET—"Sucrol is the name given to paraphenetal carbamide, a harmless substance of deliciously sweet taste, produced by adding a solution of potassium cyanate to muriate of amidophenetol. . . . It has no influence on the circulation, respiration, or digestion, nor on the nervous system in general."

PLATING—"In no branch of the electroplaters' art has there been so much progress made in recent years as in that of copper plating. With improved solutions and methods, copper plating is becoming a more important industry every day."

POWER—"In Auburn, Me., Mr. Charles Dunn, one of the most progressive brick manufacturers in New England, has arranged an electric motor to do the work of horses in grinding. . . . Other New England manufacturers are adopting the use of electricity in their plants, and with such excellent results as to premise the opinion that it will soon become universal."

TESTING—"The exhibit of Tinius Olsen & Co. at the World's Fair includes a new autographic and automatic testing machine which registers up to 100,000 pounds; a new torsional testing machine which will test bars up to two inches in diameter and sixteen feet long; a cross section testing machine for cast iron; a wire and band iron testing



Olsen testing machines at the World's Fair

machine, which was largely used in testing wire for the electrical department; a cement-testing machine, etc. Mr. Olsen has invented—and patented—a great number of improvements in testing machines and instruments. . . . The firm also make instruments for indicating the point of elastic limit, a duplex micrometer measuring instrument, etc."

FLASHLIGHT—"Aluminum, if employed in the form of bronze powder, is equal to magnesium as a source of light in taking photographs by flashlight, and is much cheaper than the latter."

MANUFACTURING—"The United States is now the leading manufacturing country in the world. We have far outstripped all other nations in the magnitude of our industrial operations. . . . In the United States we have scarcely laid the foundation for our future greatness. In natural resources we are richer than all of Europe."

TIRES—"The requisites of a good rubber tire: The envelope must be strong enough to stand a pressure of sixty pounds to the square inch, and at the same time of such lightness as to allow the air in conjunction with it to act as a perfect cushion."

"Quotes . . ."

"INDUSTRY CALLED in science years ago to solve its technical problems. The constant succession of improved and new products, together with the extraordinary advances in mass production and lower consumer prices over a long period of time, marks the success of this idea." *David Sarnoff, President, Radio Corporation of America.*

" " "

"THE NEW projects which du Pont will be ready to launch when the war is over, together with increased outlets for existing products, are expected to give rise to an all-time high in peacetime employment by the company." Lammot du Pont, chairman of the board of the E. I. du Pont de Nemours & Co.

" " "

"IT SEEMS inevitable that the American people will want to continue at least standby operation of these [synthetic rubber] plants, just as they will want to retain air bases and battleships." *John L. Collyer, President, B. F. Goodrich Company.*

" " "

"IT WOULD BE helpful if the metallurgists would be less willing to look for metallurgical causes of fatigue and insist that equally competent examination for mechanical causes be made. Until this is done, we cannot hope to make full use of our engineering materials." J. O. Almen, of General Motors Research Laboratories Division.

" " "

"I HAVE a solid conviction that trademarks and advertising have served the American people well, and by maintaining consistently high quality have won the consumers' approval. Imperfect as our system is, I prefer it to government control, standardization and any form of regimentation." *Representative Charles A. Halleck.*

" " "

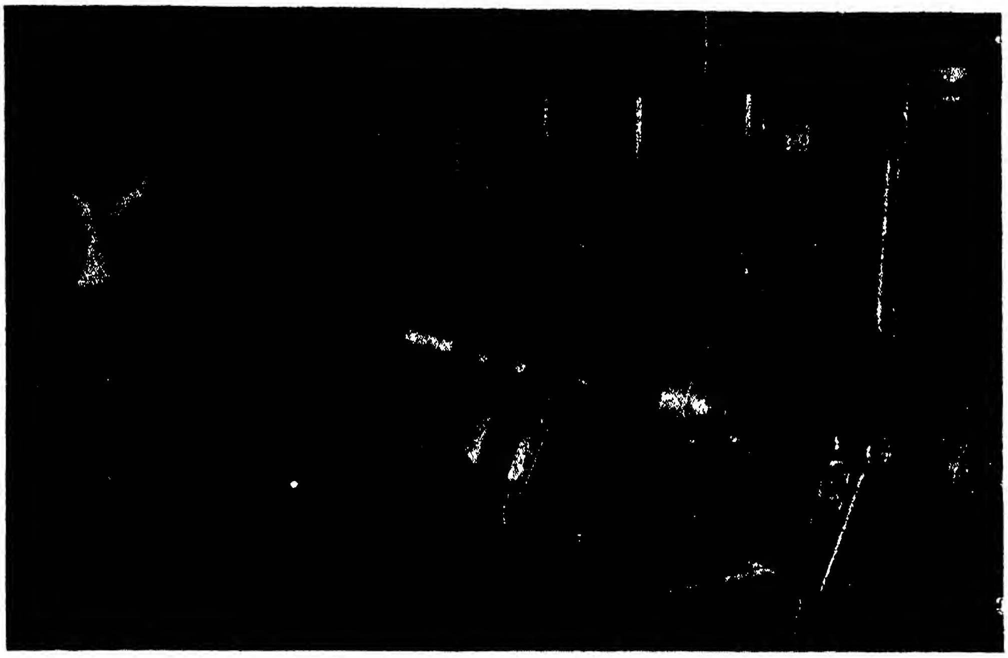
"THERE IS GOOD reason to believe that soon after the war, television will begin to realize its high promise. The technical accomplishments prior to Pearl Harbor demonstrate that television network operation is already practical, and undoubtedly much of the recent work in the field of electronics will directly or indirectly contribute to the further improvement of the art." T. A. Kennally, Vice-President, Philco Corporation.

" " "

"TODAY EVERY oil-producing area in the United States except the Texas Gulf Coast and West Texas is producing close to or in excess of its maximum efficient rate." *D. R. Knowlton, Director of Production of P. A. W.*

ELECTRONICS

Conducted by KEITH HENNEY



Frequencies all the way from 60 cycles to 50 million cycles are used in high-frequency heating. Here is a Westinghouse 3000-cycle generator which supplies power for hardening rocker arms

Electronics' Brightest Star

A Demonstration of Popping Corn Without Heat Has Led to the Development of Electronic Methods of Heating Many Materials — Metallic and Non-Metallic — by Means of High-Frequency Currents. Present Applications are Relatively High in Cost, Yet Bring Many Industrial Advantages

WHO ever heard of popping corn without heat? Up until a few years ago, no one had, and when a group of electrical engineers demonstrated this unheard-of feat, everyone seeing the actual event was highly impressed; but, having seen it, how many saw that in a few years the basic phenomenon involved would be helping the war effort and pointing toward tremendous post-war possibilities?

The initial demonstration, reported in Scientific American, consisted in placing the pop-corn grains in a glass beaker and then placing the beaker on a support between two large metal plates which were a part of a high-frequency electron tube oscillator. The pop-corn absorbed energy from the electrostatic field to which the grains were subjected, this energy appeared as internal heat, and soon the grains were popping away inside their container without the slightest visible appearance of heat anywhere near the beaker.

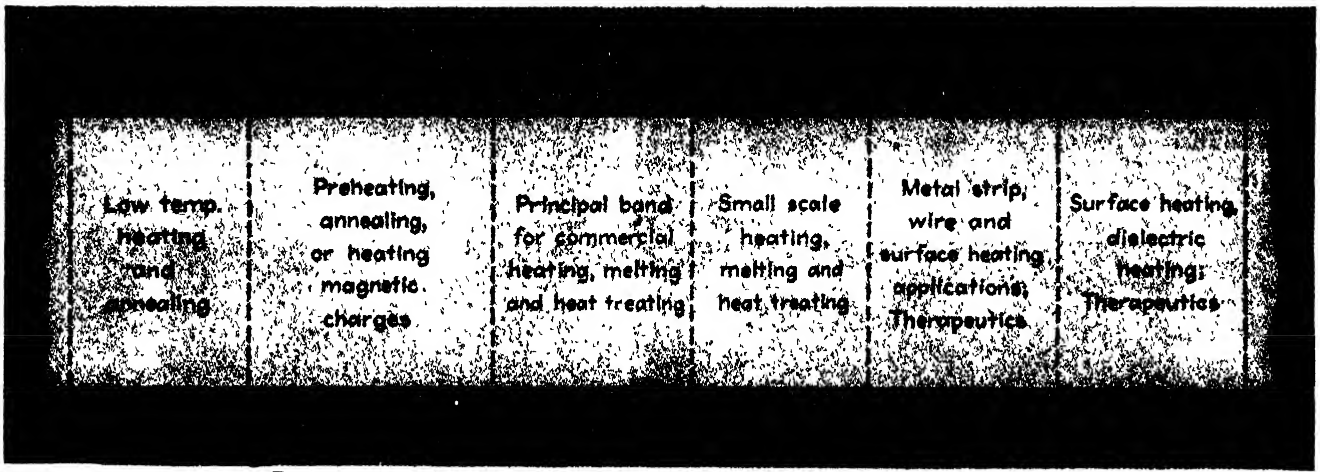
Popping corn by high-frequency heat is not a highly useful matter; but heating and drying food, plastics, lumber, rubber, and textiles, are exceedingly practical examples of this new and rapidly expanding use of electronics. So new is this application that no one is willing to wager how far into industry it will go, but anyone who bets on the short side is sure to lose his money.

High-frequency heating really started when engineers working on short-wave transmitters contracted artificial fevers. This was something new — the fact that living tissue in the vicinity of a high-frequency oscillator got warm, although the surface evidenced no rise in temperature. From this discovery came the many diathermy machines so widely used by hospitals, physicians, and clinics, and even rented out to people to use in their homes. This, however, was just a start. Heat treating by the use of high-frequency induction or by electrostatic fields has become fairly common since then and is bound to be as bright an application of electronics as welding control by electron tubes has become in the short space of a few years.

There are two general methods of utilizing high-frequency apparatus for heating. Metallic objects are best heated by placing them in an electromagnetic field such as is created when electric currents flow through a coil of wire. If only the surface of the object is to be heated, one technique is used. But if the interior is to be heated without any rise in surface temperature, another technique is required. In either case the heat is always under the control of the operator, and there is no transfer of heat as there is from flames or ovens.

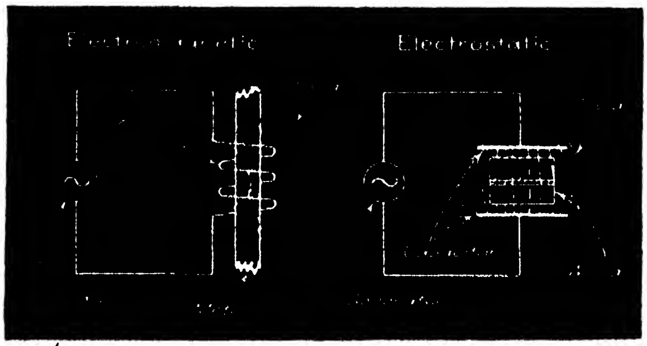
If the object is a non-conductor, like a plastic — or like the pop-corn grains — then electrostatic heating is utilized. The object is placed between the plates of an electrical capacitor. The object, therefore, becomes part of the dielectric of the capacitor, and since the material out of which the object is made is not perfect, some of the energy flowing through it is absorbed and appears as heat.

The equipment for heating by high frequencies is, to all intents and purposes, nothing but a tube oscillator similar to that employed in a radio or broadcast station. It consists of a rectifier to convert commercial frequency power into direct current and an oscillator to convert this power into alternating current of the frequency desired. Some installations are as powerful as the biggest broadcast station now in existence; others, of course, are much smaller. The frequencies required vary from 15 kilocycles (just



Frequencies used in induction heating, applications, and methods of generation

above the range of the human ear to hear) to 50 megacycles (six meters wavelength). This latter frequency is in the very high-frequency region now employed by television and FM stations and for other communication purposes.



Any material can be heated by placing it within an A.C. electric field and applying sufficient current. Field may be either electromagnetic (coil) or electrostatic (condenser)

From the standpoint of industry, the great virtues of this new kind of heat are as follows: The heat is generated directly in the object itself; no transfer of heat is involved, as is the case with open flames, hot plates, hot air, and older methods. Associated apparatus need not be heated as is true with an oven — only the object itself need get hot. The surfaces of the material need not be affected as is the case with flame heat. There need be no heat loss to the surroundings and thus the people who work with the equipment have cooler working conditions. No gases are involved and thus the likelihood of corroded surfaces, always a possibility when gases are present, is eliminated. Furthermore, the material can be heated from the inside-out and not outside-in as is necessary when the object is heated by placing it in an oven or by flames. Finally, the apparatus is exceedingly flexible so that objects of unusual size or shape or even physically inaccessible can be heated.

It is no wonder, then, that industry is looking with greedy eyes at electronic heating as a sign of progress. It must be remembered, however, that high-frequency heat is not cheap heat. The method enables industry to do things quicker, or with accurately controlled or localized heat. Thus, for a somewhat higher cost, the manufacturer in return obtains advantages which he cannot get with older methods. Radio-frequency heat may cost as much as 6 or 7 cents per kilowatt, which is in the luxury class so far as industrial heat is concerned; but the other advantages often outweigh the higher costs.

What practical operations can be performed with electrostatic heat? As a starter, consider the manufacture of compressed-wood airplane propellers. These are made up of maple sheets an eighth of an inch in thickness, impregnated with a phenolic resin and then dried. Then a phenolic glue is applied and the sheets are stacked, hand clamped, and placed in a kiln to tack the glue sufficiently to hold the sheets. Next the stack is placed on a carving machine which brings them to the required form. This form is placed between the plates of the high-frequency oscillator and power is applied to heat the entire preform up to the required temperature. Finally the assembly is placed in a die where it remains for three or four minutes. The propeller comes out in finished form without the undesirable surface hardening which resulted from previous methods using steam plates.

Before RCA engineers, co-operating with the Camfield Manufacturing Company, developed this process, a finished propeller represented an investment of 24 hours of time. Now the job can be done in 30 minutes. Thus a desirable saving in time was effected; but the added savings in labor and press facilities are not an inconsiderable part of the benefits secured.

Similar procedures are followed in making other airplane parts such as propeller blocks, spars, ribs, wing structures, and so on. So beautiful is the surface of the wooden parts made by this process that very little or no surface finishing is required. The end product is a wood block or veneered board so hard that it is practically impossible to scar it. Thus it seems to be distinctly possible that post-war products of electrostatic heating will be desk and table tops, flooring, art objects, and the like.

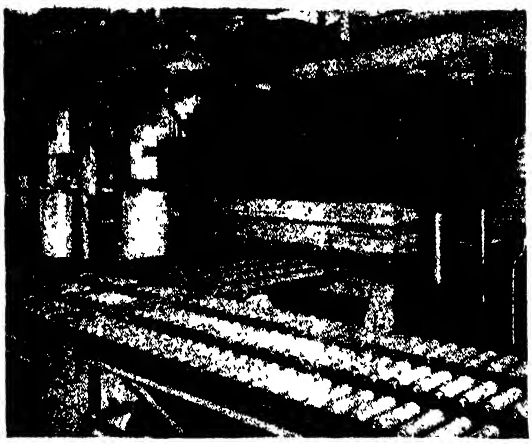
Needless to say, plastics manufacturers look to this application of electronics as a great boon not only for the time-saving factor but for betterment of product as well. After the war, civilian goods made of plastics will be manufactured much faster than with older methods; the products will be more uniform, they can be made cheaper, and much larger moldings can be manufactured. Moldings as heavy as 50 pounds are possible with present equipment.

In the electronic plastic process, a preform or rough shape of the plastic article is placed between the plates of the electronic equipment and given a pre-heating treatment before the material is placed in the mold. This rough preformed "pill" becomes uniformly heated from the inside-out through all its thickness. This plastic preform, when transferred to the mold, flows easily to all the corners to produce a finished, strong plastic part with much less pressure and in less time. The time saving is evident when it is considered that seven minutes were required for a given article before electronics was applied. Now it takes a few seconds to preheat the article, and two minutes for molding and curing. In addition to the time saved, Bakelite engineers state that two other advantages are of extreme importance. These are: Plastic parts can be molded in thicknesses and sizes hitherto impractical with standard molding methods and conventional equipment. Existing molds and molding press equipment may be used to produce plastic parts which, before the introduction of electronic molding, would have required a long wait for the manufacture of high-pressure presses.

So important has been the application of electronic heat that one well versed in the field has stated that it is the greatest single advance in plastics in 29 years.

Now from these two examples it is not difficult to think of other applications. For example, right now there is great demand for dehydrated food as a means of saving shipping space, containers, and so on. High-frequency heating is playing its part in this new

industry. Bakers have been interested in the possibility of making bread by electronic heat and thus doing away with large ovens which have to be preheated and which must inevitably absorb and dissipate much wasted heat. The problem here is whether the public will buy bread which has been baked from the inside out, since it is almost certain to be without crust. Experiments in bread baking are well in hand, and practical applications should not be long in coming into the open.



The entire bundle of veneer in the press is heated by induction to 160 degrees, Fahrenheit

Another application into which much research work has gone is the quick drying of lumber so that the time lapse from tree to useful boards is lessened. Curing tobacco is still another use for electronic heat.

All these applications utilize the phenomenon that imperfect dielectric materials will absorb electric energy in the form of heat when placed in an electric field.

Now consider metals, which are not dielectrics and which require different treatment. Place one within a coil of wire and through this wire pass an alternating current. Lines of force go through the metallic article, creating currents in the metal. Since the metallic article has electrical resistance, the currents flowing in the articles heat up the material. Power is supplied to the object, in this case not by an electrostatic field but by means of an eletcromagnetic field. There are many applications of this form of electronic high-frequency heating.

Metals may be heat treated, hardened, brazed, melted, or soldered by this new method. Another application is the rivets, developed by Du Pont, which have in them an explosive. When placed where they are to do their work, which may be quite inaccessible, they may be made a part of an electromagnetic circuit with the result that the explosive is detonated. In the explosion that follows the rivet is expanded and thus set. Fifteen or 20 rivets per minute versus one or two in the same time are now possible.

For another use of electronic heat consider the terminals on a small capacitor can. At RCA 100 of these could be done per hour by hand. Now a small blob of solder is placed on each terminal, then a loop of wire carrying high-frequency current is placed over the entire lot of terminals and all are soldered at one time. Now 2500 of them can be finished per hour.

Courtesy Bakelite Corporation

Heatronic molding turned out this complicated handset in 30 seconds

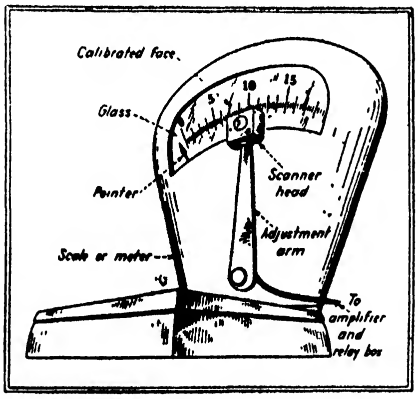
Thus far only a start on these new applications of electron tubes has been made. It is an auspicious start but it will be eclipsed by many things to come in the field of high-frequency heating.

⊕ ⊕ ⊕

PHOTO-ELECTRIC RELAY

Adapted to Batch Weighing, Metering, and So On

DESIGNED by the United Cinephone Corporation, a light and compact two-unit photo-electric relay simplifies commercial and industrial operations which use pointer-and-scale type weighing devices for automatic control of processes such as batching and container-filling. The relay is readily adaptable for use in connection with weighing devices and may, obviously, be employed in conjunction with reasonably large meters used for measuring values other than weight. Construction is such that the relay may be applied externally to existing apparatus or incorporated within weighing devices or meters of the larger variety during manufacture.



Batch weighing by electronics

SPECTROSCOPE DETECTIVE

Quickly Sorts Types of Filament Wires

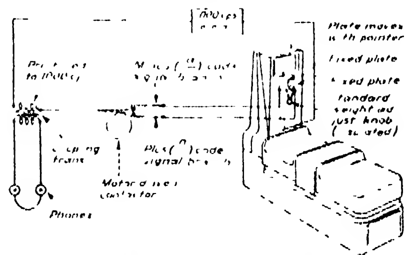
INCREASED production of high-power radio tubes being built at the Westinghouse Lamp Division has been made possible by the development of a detector that automatically sorts filament wire to determine whether it is made of pure tungsten or contains thorium.

The detection process consists of introducing a sample of filament wire into an electric carbon arc. As the wire burns completely, visible results are observed by means of a spectroscope. Two lines appear in the observed spectrum if the wire is pure tungsten while four lines appear if the wire contains thorium.

ELECTRONIC SCALE

Developed for the Blind, Has Other Applications

FOR MANY years airplane pilots have been guided by radio. The pilot wears a pair of headphones, and hears a dot and a dash (the Morse code for the letter "A') if he gets off course in one direction. If he gets off course on the other side, he hears the reverse or a dash and a dot (Morse for "N"). If he is on course he hears both signals and they join to produce a continuous tone in his ears. This was a remarkably useful concept but it was confined to this one use, until recently.



Circuit of electronic scale

A scale suggested by a Buffalo blind woman and developed by the Toledo Scale Company, transmits a continuous tone to a pair of headphones when the weight of objects placed upon its platform exactly corresponds with any selected standard weight within the range of the scale. It sends the code-letter "A" when objects weigh less than the standard and the letter "N" when they weigh more. Obviously invaluable to the blind, the scale should also prove useful to people having normal sight where, for example, an industrial process requires weighing in the dark.

A small, light metal plate is permanently fastened to the pointer of the visual weight indicating device. Two "fixed" plates, insulated from each other and from a knob which permits them to be moved to a position corresponding with the desired standard weight, are positioned in close proximity to the plate fastened on the pointer. The three plates constitute a capacitor, with the pointer plate serving as the rotor.

The capacitor is connected in a circuit as shown, the cam being cut so that two fixed contacts, connected to the fixed plates of the capacity in a branch circuit arrangement, are opened and closed in a dot-dash-dot sequence.

The predominating code signal heard in the headphones will, therefore, indicate whether objects are under or over standard weight.

Conducted by EDWARD J. CLEARY

Dollars From Sewers

Modern Purification Techniques Have Advanced to the Point Where Valuable By-Products are Obtained from Sewage Treatment Processes. Fertilizer, Gas, Grease, and Processing Water are "Manufactured" from the Liquid Wastes Collected in Sewers

Trucks rumbling through the streets of oil-starved Germany today are operating on methane gas, obtained as a by-product from municipal sewage treatment plants. In Bradford, England, sewage disposal processes are yielding 500 tons weekly of vitally needed grease. In the United States a big steel plant is buying huge quantities of liquid effluent from a city sewage plant because existing industrial water supplies are inadequate to meet expanded output.

These three examples dramatize what might be considered the ultimate in deriving salvage from waste. They focus attention on one of the least suspected sources of valuable "by-products"—the city sewage disposal system.

Interestingly enough, it was not the war that led to the exploitation of salvage from sewage. For many years, while perfecting processes that would render innocuous the foul, water-carried wastes from city sewers, sanitary engineers both in the United States and abroad have been intrigued with the possibilities of reclamation of sewage by-products. In this country the prime objective of such activities has been to obtain revenue that would help to reduce operating expenses; modern sewage treatment plants are costly to build and to maintain. Abroad, where limited resources make conservation a national fetish, the objective has been to secure fullest utilization of waste.

Most readily salvaged and the most widely used by-product from sewage disposal plants is dried sludge, valuable as a soil conditioner and fertilizer base material. Next in importance is the utilization of digestor gas—averaging about 70 percent methane—utilized for operating internal combustion engines and for gas heating. Other conservation measures include the use of effluent for irrigation and industrial water supplies, and the recovery of grease. Meantime, investigations pointing to extraction of nitrogen, organic acids, growth-promoting substances, and the production of cement and ash are under way.

To appreciate the nature and application of these salvage operations, it is necessary to review briefly modern sewage disposal practice.

Water-carried wastes collected by the intricate network of sewers under city streets are either discharged into nearby streams (a practice that is no longer acceptable in the United States and which is being corrected) or brought together in a single conduit leading to a treatment plant.

Basic functions of such a plant are to separate the solids from the liquid, and then to digest the putrescible solids. Sometimes the liquid (containing solids in solution and in suspension) is treated further by aeration or filtration through which most of the organic material is oxidized and thus rendered inoffensive.

Some idea of the magnitude of the problem involved may be gained from the fact that in every ton (240 gallons) of sewage flow reaching a treatment plant, there is only about one pound of solids, but it is this small amount of putrescible material that must be removed by treatment. A little more than 25 percent of these solids settles out in the huge, concrete sedimentation tanks provided for this purpose. The balance remains with the liquid, either to be oxidized by a subsequent treatment process or discharged into a stream or river where natural processes of purification are active.

The solids settled out in the sedimentation tanks are called raw sludge. This highly putrescible material is transferred to closed, heated (80 degress, Fahrenheit) tanks where anerobic digestion takes place. During this process, which requires about 30 days, organic materials are broken down to yield a gas containing about 70 percent methane. A stable residue remains, which can easily be dried.

The dried, digested sludge, which resembles humus in appearance and texture and is free of any disagreeable odor, is widely used for soil conditioning and has the properties of a low-grade fertilizer. Chemical anaylsis reveals that it contains an average of 2.25 percent nitrogen, 1.50 percent phosphorous, and 0.70 percent potassium. This analysis does not, however, tell the whole story.

Puzzled by the observed fact that sludge has far greater fertilizing potentialities than those indicated by simple chemical analysis, researchers finally discovered that it also contains minute quantities of "micro-nutrient" elements (boron, copper, zinc, manganese, and others) as well as certain growth-promoting substances (indole, skatole, and so on), which exert a powerful effect on plant growth.

At many municipal sewage treatment plants the demand for sludge is now exceeding the capacity for its production. Farmers, florists, park departments, and golf clubs find it ideal for their needs. Victory gardeners, too, are using it to advantage. Esthetic and health consideration rule out the use of raw or digested sludge on vegetables and fruits that are to be eaten uncooked, but otherwise there are no limitations to its use.

Some cities, of which Milwaukee is a notable example, have gone into the production of a high grade of fertilizer using sludge as a base. The Milwaukee product, known as "Milorganite," is reinforced to provide a fertilizer containing 6.0 percent nitrogen and 2.0 phosphoric acid, and is marketed throughout the United States and Canada. Chicago sells and ships huge quantities of dried sludge to Florida where fertilizer manufacturers use it as a base or "filler" material.

The use of sludge gas for operating stationary internal combustion engines has won wide acceptance in the United States, the most recent survey in 1941 showing the installation of 180 sludge gas engines. The majority of engines are under 500 horsepower but the range is from three to 1440 horsepower. They are used to generate electricity for plant operation and in many instances are directly connected to pumps and blowers.

New York City, with a total installed capacity of 11,840 horsepower, outranks all other municipalities in the use of sludge gas. One plant, at Coney Island,

Sewage treatment facilities for a large city. Sedimentation basins are at right, circular digester tanks at left, and spherical gas storage tank in the center

produces 3660 horsepower; another, at Tallman's Island, contains eight engines totaling 3840 horsepower, and the new Jamaica plant, which will soon go into operation, has three engines, each of 1440 horsepower.

Nearest competitor in size is the Mogden plant in London, where ten engines, each of 675 horsepower, are operated.

An estimate of the potential power production capacity of a city may be made on this basis: Per capita gas production from sewage solids digestion averages one cubic foot per day, which means that for every 17 persons there is the equivalent of one horsepower-hour of power. A city of 50,000 thus would have a sludge-gas power capacity of 2900 horsepower-hours per day.

Fuel value equivalents of sludge gas, which has an average calorific content of 650 British thermal units per cubic foot, are listed as follows in a report of the American Society of Civil Engineers: 1000 cubic feet of sludge gas = 1000 cubic feet of artificial gas = 590 cubic feet of natural 1100 B.t.u. gas = 6.4 gallons of butane = 5.2 gallons of gasoline = 4.6 gallons of Diesel oil.

Cost of electrical energy derived from sludge-gas generating equipment is about 0.6 cents per kilowatt-hour. This is lower than the commercial rate of 1.0 cent available to cities of 100,000 to 200,000 population.

Aside from the use of sludge gas in stationary engines, it also may be employed in internal combustion engines in vehicles. Germany, lacking gasoline and anticipating leaner days ahead, demonstrated this years ago.

In 1935, for example, about 100 trucks in the Ruhr district alone were equipped to use this gas for fuel. At least five cities had equipped their municipal vehicles for such operation.

Local sewage-treatment plants are the "filling stations" where the gas is compressed and stored in small cylindrical steel tanks. Each tank holds about 500 cubic feet of gas at a pressure of 400 pounds per square inch. With three tanks of gaseous fuel a five-ton vehicle can travel about 225 miles. The cost of operation per 100 miles is $5.71 using the gas, compared with $9.95 for oil. Necessary changes to convert an oil-operated engine for the utilization of gas are comparatively simple.

In London during the last two years it is reported that sludge gas has been lightly compressed in special vapor-proof bags for the operation of motor vehicles.

In this country the only city thus far that has given serious thought to the utilization of sludge gas for vehicle operation is Atlanta, Georgia. Studies made by Dr. Harold Bunger, director of the state engineering experiment station at the Georgia School of Technology, reveal that conversion of all city motor equipment to compressed-gas operation would yield a net saving to this one community of $8000 annually.

It was proposed that gas from one of the Atlanta sewage treatment plants should be compressed to 3000 pounds per square inch and stored in steel cylinders nine inches in diameter and five feet long, each cylinder holding 14.5 pounds of methane.

The idea was abandoned, however, when the city decided to burn the gas

Removing digested sludge for sale as fertilizer

for steam generation in the boilers of a nearby municipal waterworks. This practice is expected to provide a saving of over $6000 annually in fuel bills and is much simpler than would be the gas compressor and bottling procedure.

Estimates show that, for a population of 100,000 people, from 180 to 365 tons of crude fats are present in the sludge. Generally, it is not, however, profitable to separate grease from sewage. The value—two or three cents a pound—hardly justifies the effort; furthermore, the grease can be digested with ease along with other solids and thus provide a richer yield of sludge gas.

In wartime, on the other hand, the value of grease is enhanced because it is a source of glycerine used in powder making, medicinals, and other needed products, and thus it is that New York,

Many modern sewage plants provide storage facilities such as this spherical tank in order to furnish a constant supply of gas for engines

Chicago, and several other cities are now interested in grease recovery from their sewage disposal plants. In New York City, for example, the matter has advanced to the point where contracts are being considered with private vendors for the sale of about 50 tons of grease a month. This grease has a glycerine content of 5 to 4½ percent, compared with the 10 percent obtainable from commercial fats. The army, too, is salvaging grease from the sewers at troop cantonments.

In England, where fat shortages are more severe than here, grease from sewage is playing a major role in the war effort. One plant alone—that at Bradford—is supplying 500 tons weekly. This, however, is an exceptional case, because the Bradford sewage contains immense quantites of lanolin fat. The latter originates from washing wool, one fifth of the world's production of which is handled in that city.

Bradford began grease reclamation as far back as 1903. The first year's sales produced $1220 revenue but in recent years the revenue has exceeded $400,000 annually. Grease removal is accomplished by first adding sulfuric acid to the sewage to crack soaps and precipitate the wool waxes. The resulting sludge is then heated and filter-pressed through cotton cloth. Liquid grease and water are discharged in the process, after which the grease is treated for removal of impurities and then barreled.

Incidentally, the pressed filter cake is dried in the open and then passed through a grinder to produce a material that finds ready sale as a fertilizer. The latter sells for $7.50 a ton delivered, and in peak years has produced revenues up to $68,000.

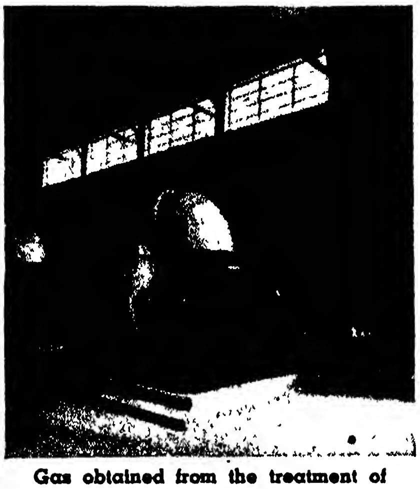
In the semi-arid regions of the West and Southwest, the effluent (liquid) from sewage treatment plants is profitably employed for irrigation purposes at a number of places. However, sanitary and esthetic considerations limit its use to crops that will not be eaten raw or to grasses used for cattle feed.

One of the most interesting operations of this kind can be observed at Vineland, New Jersey, near Philadelphia, where a sewage farm has been operated for several years, following successful use of this scheme at nearby state institutions. The sewage from this town of 8000 people is first settled to remove the coarser solids and then distributed over a 40-acre field by means of an underground tile distribution system. The soil at Vineland is a sterile, coarse sand well adapted for drainage but not suited to farming unless irrigated and fertilized. Conditions, therefore, are ideal for sewage disposal combined with farming. Because of local commercial conditions, sweet corn is the major crop. Soybeans and forage have also been produced with good success.

A unique effluent reclamation operation is conducted at the Grand Canyon

of the Colorado in Arizona. Here the Santa Fe Railway uses highly purified effluent from a sewage treatment plant for industrial needs in its shops, for flushing toilets, and for lawn sprinkling. The sewage effluent is used in place of fresh water which would otherwise have to be pumped vertically 4000 feet from springs at the bottom of the canyon, or else transported in tank cars from Flagstaff, Arizona.

One of the most spectacular examples of effluent reclamation for industrial purposes has resulted from the war. A large steel mill, faced with a dwindling supply of ground water, and too far from an ample source of surface water, laid a pipeline to a nearby sewage plant to obtain 40,000,000 gallons daily of effluent. This provides enough



Gas obtained from the treatment of sewage is used to drive the engines of these huge blowers in a disposal plant in New York City

process water for expanded steel production and at the same time brings a nice financial return to the city, which heretofore discharged the plant effluent as waste in a waterway. At the agreed rate of sale the city will net about $24,000 annually.

Taking advantage of the fact that diluted sewage effluent promotes the growth of plant algae and protozoa, all of which serve as fish food, the city of Munich, in Germany, found it profitable to combine fish culture with sewage disposal. The Munich sewage is first treated in sedimentation tanks to remove the settleable solids, and then is conducted to fish ponds covering a huge acreage of ground. The ponds are stocked with carp, a scavenger-type fish that displays great hardihood in polluted waters, and these are fattened for sale in local markets.

City sewage salvage activities are not the only concern of the sanitary engineer; the salvage possibilities from the huge quantities of industrial wastes that now pour untreated into our rivers are equally important in many respects.

These wastes are generally highly pollutional in character, thus making streams unfit for water supply, fish life, and recreational purposes. Legislative measures already taken, and a growing public resentment to such despoiling of our streams, make it inevitable that industry must undertake this abatement on a far greater scale than heretofore.

Strongest incentive for industry to provide treatment of its waste is to discover how this treatment can be made to yield some financial return in recoverable products that will help defray the cost. Progress is being made in this direction.

One of the classic examples of what can be done concerns itself with the Corn Products Refining Company at Argo, Illinois. For years this company, in co-operation with the sewage disposal experts of the Sanitary District of Chicago, has been engaged on the problem of reducing the pollutional load resulting from the processing of 80,000 bushels of corn daily. The pollution at first was equivalent to that from a population of about 400,000 people. An improved settling process was evolved whereby enough solids were recovered to reduce the population-equivalent of pollution to 270,000; furthermore, in this particular instance the reclaimed material produced an excellent stock feed. Later improvements, including the evaporation of washwater to a syrup that could be mixed with hulls and gluten solids, reduced the pollution to 75,000 population-equivalent and permitted the manufacture of more stock feed. Recovery of this by-product has been profitable and has also eliminated the need for treatment measures that would have cost nearly $3,000,000.

Treatment processes that yield a financial return and at the same time curtail pollution are being used with varying success in several industrial operations, including paper-making, sugar-beet processing, steel-pickling, canning, brewing, and chemical manufacturing. Much remains, however, to be done.

Industrial waste treatment for recovery as well as for polution-abatement ranks as one of the most important and challenging of our post-war problems.

Considering the success that has crowned the salvage efforts of sanitary engineers and chemists in dealing with the dilute, heterogeneous wastes from municipal sewers, some "miracles" in reclamation may be anticipated from the more concentrated and homogeneous industrial wastes.

⊕ ⊕ ⊕

WATER CONSERVATION
Methods of Double Use Employed by the Army

In an effort to curb wastage as well as to provide for most effective use of water where supplies are limited, Army engineers have been working on several water conservation schemes.

One of these has resulted in the design of a communal lavatory for theater-of-operations cantonments in which waste water from wash trough and showers is collected in a tank and used again for latrine flushing purposes. All waste water is drained to a 1000-gallon capacity concrete tank located beneath the floor of the lavatory, and when the tank becomes filled an automatic siphon discharges the water through an adjoining concrete pit latrine; the outlet end of the latter is connected with the camp sewer system. Dual use of water for washing and flushing will result in a saving of at least 10 gallons per man per day, which for a large camp represents a substantial amount.

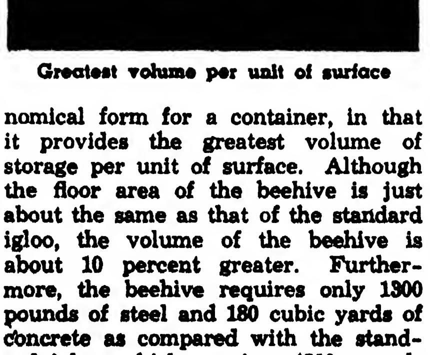
Laundry waste water reclamation has also been given attention. Processing this waste water for re-use in washing laundry or camp equipment also is estimated to save about 10 gallons per day per man. The treatment process involves segregation of the laundry waste from other waste water, addition of a lime precipitant, flocculation with air, and sedimentation.

MUNITIONS STORAGE
Facilitated by Design of New, Economical "Beehives"

Concrete "beehives" for munitions storage represent one of the innovations in underground storage facilities adopted recently by the army and navy. Developed by the Corbetta Construction Company of New York City, the patented design has been turned over to the federal government for use without restrictions as a contribution to the national war effort. About 2000 of these structures have been built or are now under construction.

Prior to December 1942, when the beehive design was proposed to the army, munitions generally were stored in semi-cylindrical barrel-type concrete igloos; the standard igloos are 80 feet long, 26.5 feet wide, and 12 feet high. The beehive, which resembles half a grapefruit resting on the cut side, is 52 feet in base diameter and is 16 feet in height. In order to simplify construction, the dome-like structure is composed of a series of polygonal sides instead of being a true spheroid.

Because it approaches a sphere in shape, the beehive is the most eco-



Greatest volume per unit of surface

nomical form for a container, in that it provides the greatest volume of storage per unit of surface. Although the floor area of the beehive is just about the same as that of the standard igloo, the volume of the beehive is about 10 percent greater. Furthermore, the beehive requires only 1300 pounds of steel and 180 cubic yards of concrete as compared with the standard igloo, which requires 4200 pounds of steel and 217 yards of concrete.

Conducted by ALBERT G. INGALLS

What Is Hardness?

Strictly Speaking, Science Doesn't Yet Know. There's Much More Philosophy to the Subject Than Meets the Eye. We Have Testers that Measure Hardness—or so We Think—and then We Define Hardness on a Basis of their Methods, Rather than Vice Versa

S. R. WILLIAMS
Fayerweather Laboratory of Physics, Amherst College

Of all tests for suitability of materials for a given purpose and for maintaining standards, hardness is the leader.

Just what, however, is hardness? The man on the street has no difficulty in understanding the term, or so he supposes. Everybody knows the difference between a hard and a soft bed; hard, medium, or soft eggs; hard and soft woods. Our thumb has been an indenter in testing fruit ever since we were able to eat an apple. "If you must pincha da fruit, pincha da cocoanut."

With all this emphasis on hardness, we still must confess that we do not know what hardness is. That is, if we require a specific definition—one expressed like those for other physical qualities, in terms of fundamental units like length, mass, and time.

By trial and error primitive man found that knives made of flint held their edge much better than other kinds of stone. They penetrated other materials much better than stone softer than flint. Man in the iron age found that, by various manipulations of his iron, he could make it (steel) harder than other samples. The soldier armed with a steel blade quickly found out that the blade of hardest steel had smaller "nicks" in the cutting edge when he crossed swords with his adversary. Thus there was borne in on man the idea that the more resistant a body was to penetration by another body, the harder was the body offering resistance. Thus, like Topsy, there has "just growed" an idea that hardness can be measured by some means wherein the resistance to penetration by some form of indenter would serve as the basis of hardness measurements.

Reaumur, the man who wrote fascinatingly about ants, evidently took the idea of the crossed swords and crossed two similar, triangular-shaped, pieces of steel and pressed the edge of one into the edge of the other. The piece showing the smaller permanent deformation of the two was the harder body. This was a procedure that many of us as boys carried out when we bragged that the steel in the blade of our jackknife was better than the one possessed by our friend, and we proceeded to cross the two blades and show that ours had a smaller indentation in its edge.

When, in the beginning of the 19th Century, mineralogists wanted to classify and identify their minerals, they found that the relative values of hardness was a great help. So arose a method perfected by Mohs in which the ability of one mineral to scratch another was made the basis of hardness measurements. Mohs used ten steps in his scale of hardness, beginning with talc as the softest and ending with diamond as the hardest. If a mineral scratched fluorite and was scratched by apatite it had a hardness number 4+ on Mohs' scale. On further consideration it will be seen that the scratch method is also a penetration method.

These methods have been described because in our evolving process of hardness measurement we have arrived at a definition of hardness based on the method whereby we measure hardness (or at least we think we have been measuring hardness), instead of first defining hardness as a certain physical property and then proceeding to find means for measuring it.

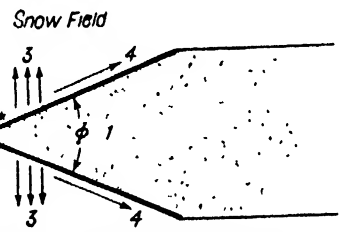


Figure 1: **Penetration resistance**

Thus we have two definitions which are essentially the same: 1. Hardness is resistance to penetration by a given indenter. 2. Hardness is resistance to permanent deformation—from which it follows also that hardness is resistance to being scratched or penetrated by a moving indenter.

In the development of methods of hardness measurement, Brinell put on the final touch. Using a definite-size hardened steel ball as a penetrator, and a definite load, the diameter of the indentation is taken as the basis for hardness measurements. So far as penetration methods go, each instrument for measuring hardness emphasizes something different. One stresses load applied to the indenter, another the depth of indentation, others the shape of the indenter, and some the material of the indenter.

Keeping the general method for the measurement of hardness in mind, we shall proceed now to ask: What lies back of hardness? What makes a bed hard or soft? How do we measure the hardness of cooked eggs, of butter, and of peaches? If our hip bones and shoulder blades do not penetrate the mattress on our bed, we say it is hard. If the butterknife doesn't slip through the butter easily, we say the butter is hard. Soft woods seem more porous than hard ones, and so are more penetrable. Resistance to penetration seems to be the basis generally understood when measuring hardness.

A snowplow, as it is pushed into a snowdrift, is a penetrator and we can ask: How hard is the snowdrift? We shall be within our rights if we say that its hardness is measured by the resistance offered to the penetration of the snowplow. We can also ask: What are the factors which determine the resistance to the snowplow?

Figure 1 shows a double-winged snowplow pushing into a snowdrift. At least five factors influence the ease with which the plow pushed in:

1. The angle between the two wings. The smaller it is, the easier the plow pushes in.
2. As the edge formed by the two wings goes in, the snow crystals must be torn apart. Solid ice would, comparatively speaking, be extremely hard.
3. The snow crystals are pushed back over each other (intercrystalline friction). The greater this intercrystalline friction is, the more difficult it is for the plow to penetrate.
4. The entrance of the plow starts snow particles sliding over the surfaces of its two wings. This frictional force is a part of the resistance offered.
5. There is a packing and compression of the snow particles. This takes energy.

Factors 1 and 4 are very much dependent upon the indenter and not upon the substance being tested. The thing we really are interested in is the separation of the particles of the material tested as the indenter penetrates it.

Dealing then with a substance like steel, if we press a hardened steel ball into the surface of the test specimen, we find that the factors in which we are most interested are those which we

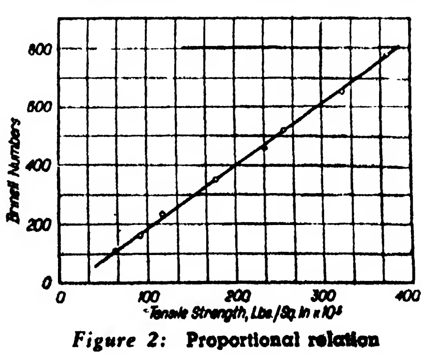


Figure 2: **Proportional relation**

call inter-atomic, and perhaps inter-electron, forces and are not much different in effect from those in our case of the snow and snowplow. If no forces exist between the particles that make up a substance, then there can be little or no force of resistance to penetration by any indenter whatsoever.

A great deal of work has been done in studying the relations between hardness as measured by an indenter method and some of its other physical properties. Among those comparative studies is that of the relation between hardness and the tensile strength of a series of steels (Figure 2). The tensile strength of a substance is its resistance to being pulled apart. This resistance to being torn apart has to do with the "snow and snowplow" factors 2, 3, and 5; with 5 playing a very minor part. The big factors, both in hardness testing and in measuring tensile strength, are 2 and 3; and therefore we see that hardness as measured by the Brinell instrument appears to be proportional to the tensile strength of the same material. This fits in with the idea of resistance to permanent deformation. A permanent deformation by the indenter of a hardness tester indicates that some of the particles have been torn from their neighbors and some have slid over their neighbors. The same holds true for tensile strength measurements; hence the relationship found in Figure 2.

During the past 25 years X-ray analysis of crystals has opened to us a vast, new world. Von Laue and the Braggs were able to show us that the atoms in most substances are arranged in an orderly, crystalline manner. Take, for example, the ordinary salt we use in our food. Figure 3 shows how the sodium and chlorine atoms are laid up in an orderly cubic fashion in a crystal of salt. Let the black balls represent the chlorine atoms and the white ones the sodium atoms. The symbol for salt is NaCl. That is, one atom of sodium and one atom of chlorine form a molecule of salt, but which chlorine goes with which sodium atom to form the molecule? We don't know, and therefore to speak of a molecule of a substance in the solid state is meaningless.

Hence, when the indenter of a hardness test penetrates the surface of a salt crystal, it is acting for the most part against inter-atomic forces. Intermolecular forces are meaningless.

The inter-atomic bonds are, in the final analysis, the bonds with which the chemist is familiar, yet there is very little to say about the relationship of these bonds to hardness. This goes to show how little we know concerning hardness and how great is the need for basic research on it.

Take, for example of inter-atomic bonds, the great hardness of the diamond. Why is the diamond so hard? We have at least two fairly good reasons. First, the carbon atom is small and so the distance between the centers of atoms is small, and (so far as we know) the inverse square law holds for the forces between them. Second, the atoms are tied together by very strong covalent bonds (sharing of electrons). The diamond has its atoms in a very tight and compact form. Figure 4 shows the arrangement of the carbon atoms in a diamond. Each atom is attached to four of its neighbors by these covalent bonds, which gives it tremendous resistance to being "pushed around." The arrangement of carbon

Figure 3

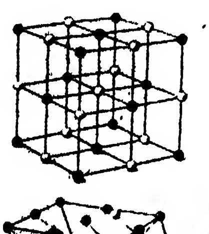
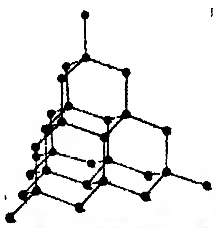


Figure 4



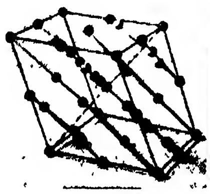


Figure 5

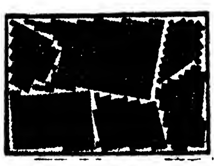


Figure 6

and silicon atoms in the abrasive compound, silicon carbide, which is almost as hard as diamond, is similar.

The thing which seems to go with these bonds which hold the atoms of carbon together so tightly is the number of electrons which flank the central nucleus of the atoms. If the outer zone is complete—that is, if it has eight electrons—that atom is an isolationist and doesn't want to have anything to do with its fellow. This is not the case with the diamond atom. Carbon is a highly gregarious atom. Each atom has four electrons in the outer zone and these pair off with the electrons of their neighbors, and it is these co-operating, covalent bonds which hold the diamond atoms so closely together and with such tenacity.

On the other hand, copper has only one electron in its outer zone, no such strong bonds are formed between the atoms of copper, and so we find copper soft, malleable, and ductile.

Size of atoms, and atomic bonds, are not, however the whole story of hardness. What has happened to a metal in which hardening has been increased by cold working? The atoms are still the same atoms as before the cold working occurred. Hardness in a metal seems to depend upon the resistance to slip between adjacent atom planes. How can this resistance to slip be changed?

In the first place what are atomic planes? We digress for four paragraphs.

We have seen that, in salt, the atoms are laid up in an orderly cubic arrangement. If now the model is turned, a position will be found where the atoms appear to line in planes. In Figure 5 is shown a model of calcium carbonate ($CaCO_3$), or Iceland spar, turned so that its atoms line in a plane. There are certain planes in a crystal which allow the atoms to slip over each other more easily than along other atomic planes. We speak of them as "slip planes."

It must be kept in mind that the models in Figures 3 and 5 are ideal. In nature and as we manufacture crystals they are not so perfect. As an example, take the case of steel. It is crystalline, as are practically all other solids, but the piece of steel as it is furnished to us from the steel plant is not one complete crystal, as is our model. Steel may be represented by Figure 6, in which we see that the metal is made up of cubic crystals of steel (crystallites) whose cubic axes in one crystallite are not in the same direction as the others. As a whole, the crystallites are arranged in a hit-or-miss fashion, as shown.

Now, what happens when the spherical indenter of a hardness tester penetrates a group of steel crystallites? The answer seems to be that the atoms composing the crystallites of steel are pushed around, or the slip planes in each crystallite become effective and the atoms move over each other along these slip planes. These slip planes can easily be seen under the microscope.

If in any way we can alter the ease with which the slip planes operate, we can thereby change the hardness of a solid. There are at least two distinct ways by which this can be done—first, by distorting the slip planes into curved or irregular surfaces and, second, by putting something in between the slip planes (figuratively speaking, throw grit in the bearings).

Returning to the case of cold rolling, or cold working, of steel, in doing this we put strains into the crystallites, which distorts the atomic planes and thus increases the resistance to slipping. The result is increased hardness. The same slip can be impeded by dissolving in the metal other constituents, usually metallic. For example, copper is alloyed with silver to make the latter hard enough for coinage. Figure 7 shows what happens to the atomic planes—at the left, when the introduced atoms are larger than those into which

Figure 7

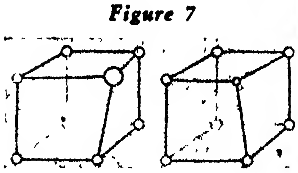


Figure 8

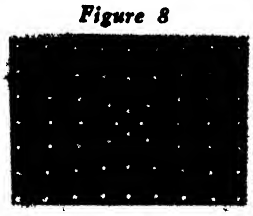


Figure 9

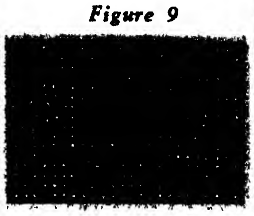


Figure 10

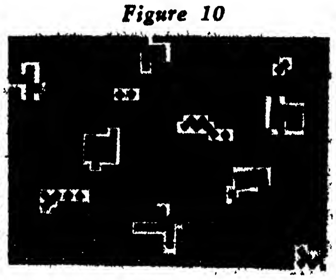
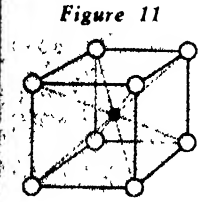
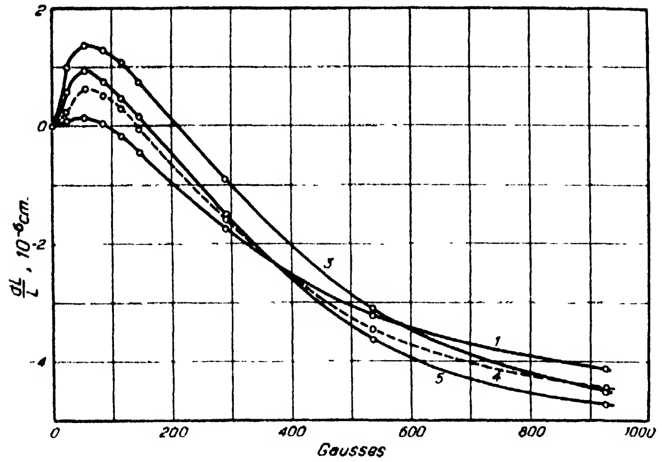
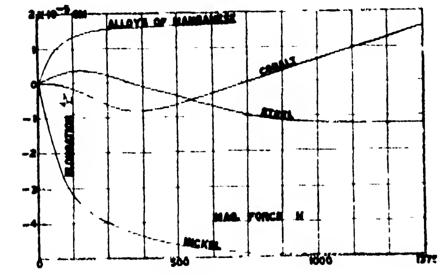
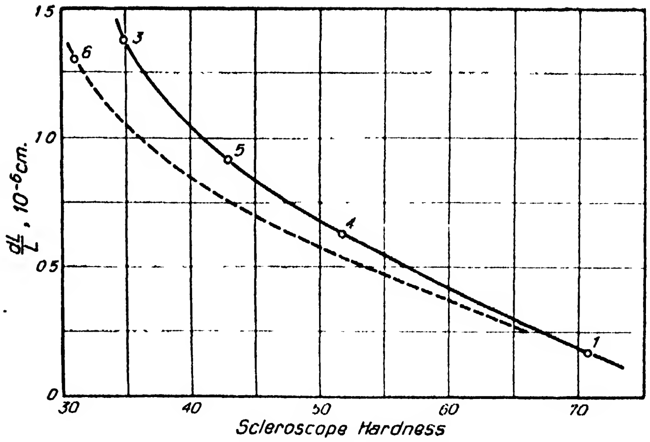


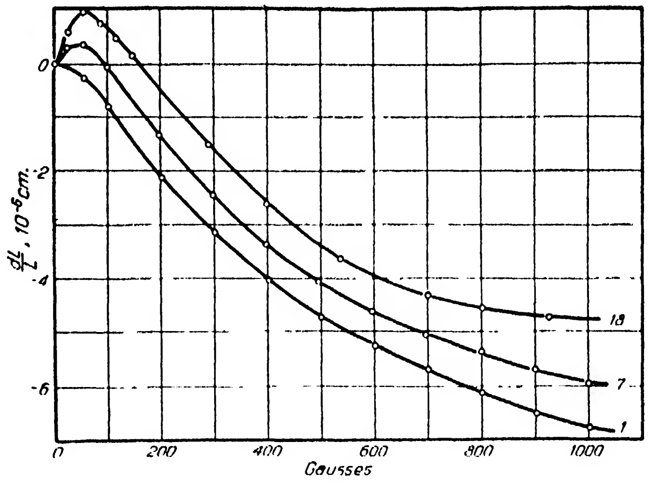
Figure 11











Lower left: *Figure 12*

Upper left: *Figure 13*

Upper right: *Figure 14*

Lower right: *Figure 15*

they are introduced, and at the right when the reverse occurs.

Figure 8 shows this condition in another way. The straight lines are the positions of the original atomic planes, but when a foreign atom is introduced, all the neighbor atoms are pulled out of the former cubic arrangement and find themselves on curved surfaces. This impedes the movement of the slip planes. Further, in some cases it is possible, by suitable heat treatment, to precipitate the dissolved constituents throughout the structure, causing more distortion, as shown in Figure 9. Not only is there a distortion, but the dissolved constituents thus precipitated act as a mechanical obstruction to the slipping of the planes, as shown in Figure 10.

Returning once more to our question about cold working of metal, the answer seems to be that, in the process of cold rolling, hammering, or drawing, distortions are set up and disregistry of atomic planes is produced by these mechanical processes which help to impede the slipping along these atomic planes. Finally, if the foreign atom introduced is too small, it may just get in between atomic planes as in Figure 11, and we have "grit in the bearings."

When carbon is added to iron, it is interesting to see how little of it (less than 1 percent) is necessary to increase the hardness many fold.

It was stated earlier that hardness depends on inter-atomic, inter-electronic forces, and thus far we have dealt with forces of the inter-atomic variety. From here on we shall deal with inter-electronic forces.

As far back as 1847 Joule made the interesting discovery that a steel rod would change its length when subjected to a longitudinal magnetic field. Later it was discovered that other ferromagnetic substances changed their dimensions in a magnetic field. Figure 12 shows how various ferromagnetics change their length for various field strengths. Joule, in describing his discovery, made the significant observation that, the harder the steel was, the less was the increment in length of the rods

Following this notation of Joule's, the writer found in studying the relation between magnetic increments in length and the hardness of a series of steel rods, that the two went hand in hand (Figures 13 and 14). Furthermore, if we take for granted that the softer the steel rod is, the greater is the increase in length of the rods, then, as Figure 15 shows, by reversing the magnetic fields on a piece of steel several times and then measuring its change in length, the increment of length increases with each series of field reversals. That is to say, by magnetically working a piece of steel it is softened. This point of view was confirmed by Herbert using his pendulum hardness tester.

Even with what we already know about hardness, much basic research remains to be done on the subject. One of the best places to get such work done is in the industries and in the development of research laboratories in industry. The firm or management which had only just a little edge on their competitors in the knowledge of what lies basically at the root of hardness would have the jump on those competing against them.

Whatever hardness testers measure, the fact remains that their ability to show whether a structural piece of steel or aluminum or some other metal is suitable for a given purpose is outstanding. They will tell at once whether the quality of a certain consignment of steel is up to specifications or not. They give most valuable information regarding such properties as tensile strength, but wouldn't it give a great impetus to the whole subject if we could really define hardness?

⊕ ⊕ ⊕

GOLDEN ROD

Experimental Plantings Have Been Completed

UNDER the program authorized by Rubber Director William M. Jeffers, the Forest Service has planted selected strains of goldenrod on about 550 acres in the vicinity of Waynesboro in Burke County, Georgia. Small experimental plots of two to ten acres were planted by the Bureau of Plant Industry, Soils, and Agricultural Engineering in South Carolina, Alabama, Mississippi, Louisiana, Texas, and California.

Only the leaves of the plant are used in processing for rubber. They may be processed immediately or stored for processing later. This year's leaf harvest will be sent to the Department's Southern Regional Research Laboratory at New Orleans for further extraction and utilization studies. In the present experimental growing operations, every effort will be made to produce a maximum quantity of planting stock, in case a larger program should prove desirable in 1944.

Conducted by FRED P. PETERS

Hard, Corrosion-Resistant, Slippery

The Story of the Conversion of That Popular Glamour Metal, Chromium, to an Essential Machine-Shop Material for the Production Front—Some of its Unsuspected Properties and New Uses, its Conservation Aspects, and its Future Place Among Industrial Materials

Although this is an era of new industrial materials, there are less glamorous but no less significant parts of the materials picture which concern new applications of old materials—applications so fundamental as to raise the stature of the old material in its new application to that of a new industrial material. Outstanding in this class is the fast-growing use of chromium plate for a variety of industrial applications that are entirely independent of the familiar decorative appeal of this coating.

Chromium plate is today serving industry in many ways that are new and for which no other material of comparable properties exists. "Chrome plate" is the beautifully lustrous finish that made American automobiles and electric appliances the shiniest on earth; but it is also among the hardest and most wear-resistant materials known, and its frictional qualities (slipperiness or bearing properties) place it in the ranks with the best among all other metals.

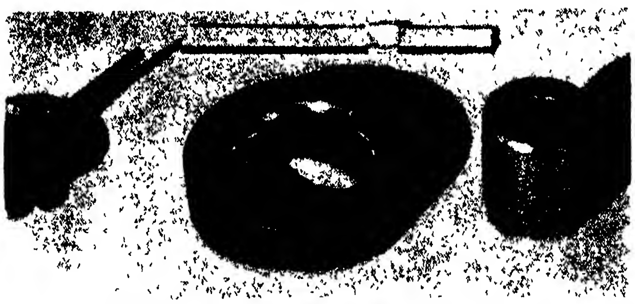
But most important of all: Chromium plate in its wartime overalls is providing the life-saving answer to a critical shortage of small tools and dies and is extending the utility of this country's tool-steel alloys—tungsten, chromium molybdenum, vanadium, and cobalt—machine tools, and manpower by truly tremendous amounts.

Dr. Arthur W. Logozzo, of the Hartford Chrome Corporation, a pioneer in the industrial use of chromium plate, characterizes this bright metal coating as "the greatest life prolonger of new equipment and one of the greatest single salvage mediums" we have today. Chromium plated gages, for example, outlast un-plated gages by four times or more. This means not only 400 percent more production from the particular quantities of critical metals present in the gage, but also circumvention of the painful problem of obtaining new gages quickly from today's heavily overburdened tool-making facilities. Then, too, gages are expensive and the cost savings in prolonging their life are not to be ignored.

The story is the same with cutting tools, forming dies, and molds, some of the plated tools giving ten times the life of those unplated. Most ammunition manufacturers who do any drawing of copper, brass, and steel, for example, chromium plate their new dies and punches, enjoy enormous life extensions (since they replate the tools several times), and find in addition that the plating on the dies eliminates sticking during drawing.

For salvaging machinery parts or dies that have been worn or mismachined undersize, chromium plate deserves an Army-Navy "E" all its own. Production rejects that would otherwise be scrapped because, let us say, the parts are not thick enough, are now heavily chromium-plated to the correct dimensions and put into use. Worn bushing bores that are too large are chromium-plated to reduce the inside diameter and are thus completely reclaimed.

Potentially the largest industrial field for chromium plating may be its use as a production finish on aircraft, Diesel, and automotive engine machinery and pump parts that must resist wear or corrosion. Many manufacturers of warvital machinery now obtain smoother operation and much longer life by using chromium-plated pistons, rods, shafts, cylinders, press rams, guides, cams, bearing rollers, and so on. The recent development of *porous* chromium plate, which provides a hard, wear-resistant, and oil-retaining surface for Diesel cylinder bores, pistons, rings, and similar parts, is expected by many to have the greatest influence of all on the high place chromium plate may ultimately occupy among industrial materials.



Examples of chromium-plated drawing dies

The *quality* of the chromium deposited for industrial applications is essentially the same as that which is plated for ornament. For many years people thought there was a necessary difference between the hardness of industrial and of decorative chrome plates, and hence applied the term "hard chrome" to industrial coatings and "decorative chrome" to the brilliant ornamental plate. Actually, tests have proved that the bright plates are among the hardest available (1000 to 1025 Brinell), and bright plates are consequently universally applied as the best for industrial uses.

There is an interesting reason, though, for the general impression that decorative chromium is softer than industrial. A file drawn across the surface of a brilliant chrome-plated belt buckle or hub cap will invariably scratch it, while the same file will fail to leave its mark on an ordinary chromium-plated drawing die or machine spindle. The natural conclusion from this is that the industrial plate is harder than the ornamental, but the facts are that the ornamental plate is *thinner* than the industrial—so thin that the softer base metal underlying the decorative chromium film "gives" under the file edge. The chromium is gouged in much the same way that a toothpick would press a groove into the tin-foil wrapper on a piece of cheese. Industrial chromium coatings are usually thick enough (or the base metal is hard enough) to prevent this "anvil" effect.

Actually, both types of chromium plate are inherently harder than the file, so that a file test merely indicates the thickness and not the hardness of chromium plate. Drs. C. G. Peters and Frederick Knoop, of the Bureau of Standards, demonstrated three years ago that hardness tests on plates thinner than one thousandth of an inch (0.001 inch) reflected the hardness of the base metal, whereas plates thicker than that were unaffected by this factor.

The most important difference between decorative and industrial chromium plates, then, is *thickness*. For decorative chromium plating a thickness of about one or two hundred-thousandths of an inch (0.00001 to 0.00002 inch — about 1/200th the thickness of a human hair) is generally used. Except for a few applications requiring plates approaching that thinness, industrial chromium plates run from one ten-thousandth to 25 thousandths of an inch thick (0.0001 to 0.025 inch). Good practice is to apply the thinnest coating that the hardness of the base metal will permit.

Because of their greater thicknesses, industrial chromium coatings take longer to apply, and this must be taken into consideration in the operation and control of the plating bath. Several processing factors not encountered in decorative plating, such as the avoidance of excess plating at corners and edges, the importance of good adherence to the base metal, and the finishing of the deposit to very precise dimensional tolerances, confront the

plater who applies industrial chromium.

Engineers of United Chromium, Inc. (the company whose basic patents dominate the chromium-plating field) have made exhaustive surveys and tests of the technical properties of chromium plate. Examination of their results shows not only that chromium is superlative in many ways, but also that its combination of high hardness, corrosion resistance, wear resistance, resistance to heat, and frictional and surface properties is available in no other industrial material yet discovered or developed.

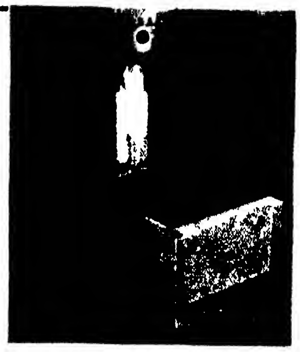
For example, the hardness of correctly produced bright industrial chromium plate is about 1000 to 1025 Brinell. This hardness is of the same degree as that of nitrided steel (one of the hardest engineering metals) or sintered tungsten carbide (the hardest type of cutting-tool material).

Several years ago the Worthington Pump and Machinery Corporation, curious about chromium plate's ability to serve as a bearing material in comparison to that of the usual bearing metals, made sliding friction tests on a number of shaft and bushing combinations. The standard bearing combination of steel on babbitt metal had a coefficient of friction of 0.20. When the babbitt was replaced with chrome-plated steel, the new combination ran much easier, with a coefficient of 0.16. The engineers who made these tests concluded that "chromium has the lowest coefficient of friction available in any of the structural metals." This conclusion has since been reached by other researchers.

The third outstanding quality of electrodeposited chromium is its unusual resistance to corrosion and chemical attack. These characteristics are utilized in many familiar applications of chromium plating. Where so used, chromium plate is usually applied over intermediate deposits as, for instance, copper and nickel on steel or nickel alone on copper or brass. The function of the underlying deposit is to prevent the exposure of the basis metal through any pores that may exist in the layers of electrodeposited chrome. Properly plated articles are resistant to tarnish, rust, and corrosion, and thereby are of great value in prolonging the usefulness of the product to which they are applied.

Also important among its characteristics are chromium plate's amenability to use *and reuse*, as a "putting-on tool" (for adding metal where needed), its adapability to precision operations, its resistance to oxidation at high temperatures, its high melting point, and its relatively low cost from the engineering point of view.

Lest exaggerated conclusions be drawn from these facts, it is pointed out that chromium plate is not a cure-all or panacea. For example, it is not necessarily the best bearing metal in the world, since there is considerably more to bearing performance than just the coefficient of friction. It is certainly not the hardest engineering material one can find, and it is surpassed in corrosion resistance by a few (mostly noble) industrial metals But it is just about the hardest material available which is also corrosion-resistant and "slippery," and its growing list of applications in special services stems from this unique combination of properties.



The long list of applications which chromium plate is finding in industry is exemplified by the plated tap (right) being used on a hard rubber part, the side milling cutter (below) in use on steel, and the twist drill (lower left)

The use of chromium plating as a "putting-on tool," for adding metal to surfaces that have been worn or mismachined undersize, is its major contribution to industry. Some typical instances of smart reclamation of off-size rejects by chrome-plating were recounted in detail in an article in the June 1941 issue of Scientific American, and little need be added here. Intricate parts, gages, tools, dies, and fixtures representing many hours of skilled tool work, much precious machine time, and important amounts of critical alloys are being saved from scrap piles everywhere by alert plating departments.

At one plant, plating thicknesses have run up to 40 thousandths of an inch (0.040 inch) and over 10,000 parts have been salvaged in the last few years. Many manufacturers who started using chromium plating for salvage work found the service life of the reclaimed parts so much improved that they now specify chromium plating as standard on these parts even when new.

In the field of new tools and parts, the applications of chromium plating may be simply divided into (a) cutting tools, (b) gages, dies, and molds, and (c) wear-resistant machinery parts. For industrial chromium plating the thinnest coatings are those applied to cutting tools, such as cutters, reamers, drills, taps, broaches, and so on. For applications like these, involving sharp edges or impact, deposits heavier than a few ten-thousandths of an inch tend to spall or chip, so that the practice is to hold the plating to thicknesses between five ten-thousandths and five hundred-thousandths of an inch (0.0005 and 0.00005 inch).

Mr. T. G. Coyle, technical director of United Chromium, Inc., explains in addition that the best plate thicknesses for tools used for cutting steel are different from those for cutting plastics or soft metals. He suggests this generalization. *The harder the material being cut, the thinner need be the chromium deposit.* Most of the benefit of chromium plate on cutting tools arises not so much from the extra hardness of the plated tool but from the lower coefficient of friction between the plate and the material being cut, whereby the chips slide off along the tool more easily.

The quantitative extent to which industrial chromium plating is providing a large part of the answer to the shortage of small cutting tools and tool-steel alloys by enormously extending their lives is indicated by the job records of many manufacturers. For example, at a Canadian plant (John Inglis Co., Ltd.) one tool, a 0.237-inch diameter reamer, would, when unplated, turn out 15 pieces before it had to be reground; after chromium plating, 75 pieces between grinds was a common figure (an increase of 400 percent) and, furthermore, the tool could be continually replated and re-used at its original size.

Reports on chromium-plated plug gages indicate life increases because of chromium plate ranging from seven to twenty times that of the unplated gage. On a few special gages, chromium plate has shown several hundred percent longer life than carbide tips—and that is an achievement!

According to Mr. Coyle, gages are generally finished with a chromium plate 0.001 to 0.015 inch thick. In some gaging operations, where tolerances are extremely small or the gage must have a sharp working edge, the chromium plate thickness should be much less than 0.001 inch—only of the order of 0.0001 to 0.0003 inch.

Since gages are sizing tools, dimensional precision is important. In cases where the thin deposits are used (and with some of the thicker, too), the gage may be plated directly to size with sufficient accuracy, but generally

it is more practical to over-plate and then grind or lap back to size after plating.

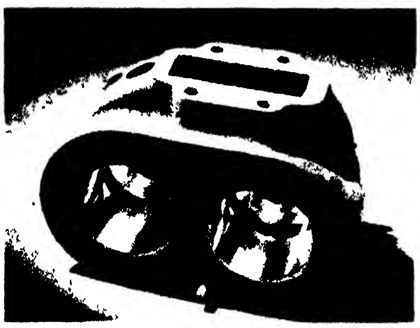
Chromium-plated dies and mandrels are almost universally employed for drawing seamless tubes of steel, stainless steel, brass, and aluminum. Tool-life increases of eight to ten times are reported, together with improved tube finishes.

A field that is very active at present and a potentially even busier one in the future for chromium is the plating of molding dies for plastics. Naval specifications now require it on molds for Navy Department parts and the largest fabricators have also swung over to plated molds. The plate thicknesses run from 0.001 to 0.005 inch.

The plastic or rubber parts made in plated dies are smoother; sticking, fouling, and pin breakage are eliminated; and the flow of the compound along the die walls is facilitated. For a given amount of wear, the chromium surface produces 10 to 15 times the output of the hardened (unplated) steel surface in some shops. Chromium-plated dies are also used in powder metallurgy, where die problems have been traditionally acute.

Porous chromium is potentially important enough to receive special attention here. Today it is doing yeoman service as the surface on countless Diesel engine cylinder bores aboard ship and elsewhere. These important Diesel applications have been pioneered by Mr. Henrik Van der Horst, a former Hollander who spent years in developing this solution to a specific problem—the wear of cylinder bores, piston rings, and ring gaps in Diesel engines, especially two-stroke engines.

Originally the cylinder bores were merely plated with dense bright chromium, and general improvement in performance was obtained. But



Chromium plated cylinder bores

some bores would score, even after honing to a high polish, until one day someone observed that the chromium surfaces that did not score were slightly pitted. It then became clear that for oil-film bearing applications like this, not only hardness but a *rough* surface was necessary to retain the oil on the normally non-absorbent chromium surface, and research was directed to the development of a uniformly porous hard-chromium layer.

Cylinder bores treated in this way wear away at a much lower rate than ordinary cast-iron bores, will outlast alloy cast-iron bores by seven times and nitrided bores by three times. In

Hard-rubber molding dies are plated

Diesel-operated ships, for example, this means fewer delays and layovers while cylinders are replaced, relined, or rebored or rings replaced, and even making trips that might normally be cancelled because replacement parts could not be obtained.

The use of porous chromium plate on internal combustion engines generally and for other oil-retaining bearing surfaces is now receiving the most widespread attention, with both the Van der Horst Corp. of America, Inc. and United Chromium, Inc. conducting research on processes and applications.

The exigencies of war have brought to industry sudden recognition of the value of chromium plate as an engineering material, and the process and its applications have developed with unbelievable rapidity. When peace returns, the pressure for salvage will be off, but many companies—the smarter ones—will continue the reclamation practices they found so helpful during the war.

Quite apart from salvage, we may confidently expect the use of chromium plate on such new parts and tools as drawing and extruding dies, molds, burnishing broaches, hydraulic equipment parts, bearings, and so on, to continue to expand, because for many of these it will be simply intelligent design and economics to use it. Those applications involving stainless steels, light metals, plastics, powder metallurgy processes, and engine parts should be especially important in the years to come. Of all the present-day applications of chrome-plating, the use of porous chromium as a hard, wear-resistant oil-retaining surface for Diesel cylinders and rings, gas-engine cylinders and pistons, *and hundreds of other parts not yet exploited* may be ultimately the most important.

⊕ ⊕ ⊕

LEAD-ALLOY COATING

For Copper Wire, Satisfactorily Replaces Scarce Tin

Much of the wire normally used for electrical conductors in normal times was coated with pure tin to facilitate soldering of joints and connections and to protect the underlying copper and its rubber insulation from reacting with each other. The shortage of tin, however, impelled a search for materials that comply with the WPB order limiting the tin content of copper-conductor coatings to 12 percent and which will perform satisfactorily.

The requirements for such coatings are amenability to fast soldering, good resistance to abrasion, excellent anti-friction properties, and resistance to corrosion by sulphur and by rubber chemicals.

Of all the possible substitutes tested by Anaconda Wire and Cable Company (including lead-base alloys of less than 5 percent tin), the only one that approached the desired properties was an alloy of lead to which small amounts of cadmium, tin, and antimony are added. Average analyses of coatings from the new alloy show 5.23 tin, 1.17 cadmium, 0.30 antimony, and 93.30 percent lead.

The alloy has been in continuous use (under wraps) for 16 months, during which 500 million pounds of wire has been coated, stranded, and insulated with satisfactory results. Statistical analysis of the substitution shows that approximately 87 percent of the tin previously consumed for this application is being saved by the use of the new alloy. At Anaconda this means a saving of about 3500 pounds of tin per month.

BERYLLIUM-COPPER

Improved for Many Uses by New Heat Treatment

Expanded wartime applications of beryllium-copper have taught materials engineers much about the properties that are best for individual applications and about the methods of heat treatment best able to provide these properties.

Beryllium-copper's greatest contribution today is in the field of aircraft, instrument, and electrical springs, where its combination of exceptional strength, corrosion resistance, high endurance, flexural and torsional strengths, and susceptibility to hardening *after* forming make it a nearly ideal material.

Recent intensive studies have shown, however, that peak properties cannot be obtained by the standardized heat treatment usually recomended, that the work and treatment given the beryllium-copper at the mill that sells it to the spring fabricator profoundly influence the results the latter obtains with it, and that each lot of beryllium-copper for springs must be individually tested and treated by the spring maker if the full value of the metal is to be obtained.

The heat treatments used will thus be individually different for each lot, but the new data show that the practice of hardening the annealed and formed springs by heating for a given time between 500 and 600 degrees, Fahrenheit, should be changed to a shorter time at higher temperatures—between 600 and 700 degrees. Springs processed by the new schedules have much better "drift" properties (drift is the tendency to become permanently elongated by minute amounts through stress *below* the elastic limit at room temperatures) and are generally superior.

Conducted by JAMES M. CROWE

Synthetic Rubber Today

Enough Can Now be Told About Synthetic Rubber to Indicate that the Problem of Replacing Natural Rubber in Many Vital Applications Will be Solved Satisfactorily. A Resume of the Most Important Synthetics, Their Composition and Qualities, and Raw Materials Used

AT THE END of 1941 the total installed capacity for production of synthetic rubbers in the United States amounted to only about 20,000 tons. Then came Pearl Harbor and the war-necessitated miracle of increasing this synthetic capacity to nearly a million tons by the end of 1943.

Generally speaking, the synthetic rubber-like materials on which the United States will depend for its rubber during the present war may be divided into a number of types. It would require volumes to tell the detailed story of the manufacturing processes and properties of these many materials, and even then it would probably be inaccurate. Specific operating details have never been made public and the technology is changing so rapidly under the stimulus of all-out research that methods are changing and improving every day However, the following brief and general descriptions, derived from a Bureau of Mines survey, will explain the nature of the more important of the synthetics, the way they are produced, and their general applications.

BUNA S: Copolymerized butadiene and styrene, synthesized by copolymerization in aqueous emulsion.

Buna S has been made in large quantities in Germany since 1936 as a general substitute for rubber, particularly in automobile tires. A small amount was made in this country prior to the war Of all the various types of synthetic rubber that have been developed, each with special advantages, the Buna S type seemed best for rubber's major uses, and could most easily be fabricated with existing equipment. The government rubber program was, therefore, largely concentrated on this type. Buna S, more recently designated GR-S, is now manufactured by a number of companies on a large scale for use in tires and as a general substitute for natural rubber. Out of the 850,000 tons annual capacity undertaken by the government rubber program, 735,000 tons or about 86 percent is Buna S.

The raw materials used in Buna S are butadiene and styrene. The butadiene may be made by many methods from a number of basic materials, present commercial sources of butadiene being petroleum and petroleum gases, coal or coke and limestone, ethyl alcohol, and butylene glycol made by special process of fermentation of grain.

Much of the early confusion about synthetic rubber arose from a lack of appreciation of the fact that Buna S is exactly the same product whether made from butadiene derived from oil, grain, coal, or whatever source.

Styrene, the second requirement for manufacture of Buna S, has been manufactured for some time for use in the plastics industry; hence, the principles involved in its production were quite well known. The most common method consists of processing ethyl benzene produced from benzene and ethylene or ethyl alcohol. Styrene may also be produced by high-temperature cracking of petroleum.

In general, the properties of Buna S are similar to those of natural rubber, and the swelling characteristics in gasoline and mineral oil are but little better than those of natural rubber. Water absorption is only 65 percent that of natural rubber, and aging qualities are considered superior It is useful for coverings in the cable industry because of the last-named qualities.

PERBUNAN (formerly Buna N): Copolymerized butadiene and acrylonitrile in an aqueous emulsion. The butadiene is obtained from the same sources as given above, while the acrylonitrile is made by treating ethylene with hypochlorous acid to give ethylene chlorohydrin, which reacts with sodium cyanide to give hydracrylic nitrile, from which acrylonitrile is obtained by dehydration.

A primary property of Perbunan is its resistance to the action of gasoline, petroleum, and aliphatic hydrocarbons. However, it is soluble in aromatic and chlorinated hydrocarbons such as benzol, toluol, solvent naphtha, di- and trichlorethylene, and in certain ketones.

Aging qualities and resistance to ozone are said to be superior to those of natural rubber, but elasticity, rebound, and electrical properties are poorer. Because of its poor electrical properties, Perbunan is not used as electrical insulation. In heat resistance and abrasion resistance it surpasses natural rubber and is less than half as permeable to air and gases. Hard compounds made from Perbunan have high softening points and superior resistance to many solvents.

Perbunan finds greatest use where its oil-resistant qualities are needed —oil-resistant packing rings, gaskets, printing rolls, gasoline hose, hose for spraying paint, cable covers, conveyor belts, and the like. Although Perbunan tire tread compounds are said to be equal or superior to the best rubber tread compounds, its use in tires is not of commercial importance, as other synthetics easier to process and fabricate are considered economically more suitable for that purpose.

Perbunan Extra is similar to Perbunan except that the acrylonitrile content is greater. It is easier to process, more resistant to oil.

HYCAR "O R" (AMERIPOL): Butadiene copolymer, reported to be a copolymer of butadiene and acrylonitrile similar to Perbunan. Two distinct types are being made. The raw materials are butadiene and acrylonitule. (See Buna S for butadiene sources and Perbunan for acrylonitrile).

Properties of Ameripol, such as tensile strength and elasticity, are said to vary over a wide range according to the method of compounding. Good heat and abrasion resistance are claimed, and superior resistance to mineral, animal, and vegetable oils and fats, to oxidizing effects of metallic soaps used as driers in paints and inks, to all petroleum products, and to benzene, alcohol, water, and carbon tetrachloride, although it is badly swollen by acetone. Its age resistance is superior to that of natural rubber and its resistance to acids and alkalies is about the same. Elasticity, tear resistance, and rebound are lower than for similarly compounded natural rubber. Hardness may be varied over a wide range. It becomes stiffer than natural rubber at subfreezing temperatures but is reported to be still flexible at —50° Centigrade. Resistance to oxidation and decomposition when exposed to heat is said to be

Synthetic rubber tires for the armed forces

Butadiene storage tanks at a Carbide and Carbon Chemicals Corporation plant

excellent, and it is less permeable to air and gases than is natural rubber.

Oil-resistant products made from Ameripol include gasoline hose, automobile and airplane parts, packing joints and valves, lining for bulletproof gasoline tanks, printing rollers, and the like. Tires of Ameripol are said to be slightly superior to tires made of natural rubber compounds in abrasive resistance, and far superior in the presence of oils and high temperatures.

The synthetic is used to produce a hard rubber compound, "Ebonar," which is said to have an outstanding advantage over hard natural rubber in that a higher softening point is obtainable.

CHEMIGUM: Butadiene copolymer, said to be a copolymer of butadiene and acrylonitrile similar to Perbunan.

A Buna-type synthetic rubber, Chemigum is tough and is equal or superior to natural rubber in strength, aging resistance, and resistance to sunlight. It is much less soluble in conventional rubber solvents than natural rubber, and its oil resistance makes it suitable for use in gasoline hose and the like. Tires made of Chemigum are said to give performance equal to or exceeding natural rubber tires.

NEOPRENE (formerly DUPRENE): Polymerized chloroprene made by polymerization of chloroprene in emulsion under carefully controlled conditions. Raw material is calcium carbide, made from lime and coke in a high-temperature electric furnace, which gives acetylene when treated with water. Vinylacetylene, formed by polymerization of two molecules of acetylene, is treated with hydrochloric acid to give chloroprene. The physical qualities of Neoprene may be modified over a wide range by the proper choice of pigments, accelerators, anti-oxidants, and so on.

Neoprene is made in several types, Neoprene G being a new, improved, relatively odor-free type which is thermoplastic and is formed, like rubber, by calendaring, extruding, and molding at high temperatures.

The vulcanized product is resistant to oils, and although virtually all animal, vegetable, or mineral oils cause it to swell somewhat, it usually retains its properties better than rubber. It is slightly less elastic than rubber but is more heat-resistant and resists sunlight better. It has approximately the same tensile strength as has similarly compounded rubber. The abrasion resistance of Neoprene tire treads is said to be about equal to that of the best rubber tire-tread compounds. Neoprene and rubber show about equal abrasion resistance when dry, but Neoprene is many times more resistant to abrasion after having been soaked in oil.

Neoprene is used for tank linings; reaction vessels; conveyor belts; gaskets; hose for oils, solvents, and gases such as chlorine; clothing for acid protection; laboratory tubing; and for similar purposes.

VISTANEX: Polymerized isobutylene, made by polymerizing isobutylene at low temperatures with catalysts of an acidic nature, such as titanium tetrachloride, boron fluoride, and aluminum chloride. Isobutylene is present in large quantities in gases from refinery cracking operations, and may be made by dehydrogenation of isobutane, which is obtained from natural gases or from isomerization of normal butane.

Vistanex possesses unique qualities, owing to its lack of unsaturation. It exhibits extreme resistance to ozone, acids, alkalies, and corrosive salts and has excellent aging properties, especially at high temperatures. Its water-absorption and vapor-permeability properties are extremely low. It is resistant to most vegetable and animal fats, oils, and greases, and is insoluble in alcohols, esters, ketones, and most organic solvents containing oxygen; but it is soluble in petroleum and coal-tar solvents and in some chlorinated solvents. It has excellent electrical properties. It is less thermoplastic, and the degradation or breakdown by mechanical milling or mixing is less than for natural rubber.

Vistanex is used in the manufacture of cable sheathing, acid-resistant linings, electrical insulation, adhesives, artificial leather, and the like. It may be compounded with natural rubber in certain proportions to give a curable product useful in steam hose, conveyor-belt covers, cable coverings, and other products resistant to aging or chemical action.

BUTYL: Copolymer of a butene and a diolefin, produced by low temperature copolymerization of isobutylene and a small amount of butadiene or other diolefin. Isobutylene is procured from petroleum by cracking.

Butyl rubber is outstanding in that it possesses only 1 or 2 percent of the available unsaturation of natural rubber, which is just enough for vulcanization. This lack of unsaturation gives butyl rubber unusual properties in aging resistance and in stability in the presence of ozone. It swells like natural rubber in petroleum and coal-tar solvents but does not swell in most vegetable and animal fats and oils. It is resistant to acids, including sulfuric and nitric, has low water absorption, high heat resistance, and excellent flex resistance, and is highly impermeable to air and gases such as hydrogen, helium, and carbon dioxide. Its rebound is low at room temperature but high at high temperatures. Electric properties are said to be such as to make it outstanding for cable insulation.

Butyl rubber is said to be satisfactory for inner tubes, as it holds air longer than does natural rubber and is considered superior to certain other synthetic rubbers for this purpose, although some difficulties have been experienced. So far, automobile tires made of butyl rubber have shown a life about 50 percent as great as that of natural-rubber tires if used at speeds under 40 miles an hour. Besides its use in tires and tubes, it is recommended for use in fire and steam hose, molded goods, tank linings, conveyor belts, and in general replacement of natural rubber.

FLEXON is similar to butyl rubber except that it is produced at different temperature in an open vessel. It usually has qualities inferior to butyl.

THIOKOL: Organic polysulfide obtained by a reaction between organic dihalide and alkali polysulfide.

The raw materials used in Thiokol depend on the finished type. Ethylene dichloride and sodium tetrasulfide give Thiokol A; dichloroethyl ether and sodium tetrasulfide give Thiokol B; and so on. The sources of these raw materials are organic compounds which may be obtained from petroleum products, chlorinated by the use of chlorine obtained from salt. The sulfides are made from sulfur and alkalies.

Thiokol has been made in several types and from several primary materials. A variety of products, some of which are rubber-like and some of which are not, can be made by varying the kind of polysulfide and hydrocarbon. Some of the products are used in the plastics industry and some as a rubber substitute. The rubber-like types are soft and plastic and can be worked on a rubber mill and reinforced and modified by the addition of compounding agents just as with natural rubber. They are particularly resistant to organic solvents.

Thiokol is not suitable for tire treads, although a new type (N) is said to be suitable for recapping tires. In general, Thiokol may be used where high resilience, tensile strength, and resistance to heat are not important, but where good aging characteristics, resistance to ozone and solvents, and flexibility are required. It is used in the automotive industry for coating paper gaskets, where it flows under heat and pressure into tool marks and imperfections to make a perfect oil seal. It is used also

in the manufacture of gasoline and paint-spray hose, printers' blankets, rubber printing plates, and cable coverings.

THIOKOL R D: Copolymer obtained from butadiene and acrylonitrile. In the raw state it is a tough, resilient, amber-colored, solid with excellent resistance to gasoline, oil, and other solvents. It has high tensile strength, up to 3000 pounds per square inch, and good abrasion resistance, comparable to natural rubber.

KOROSEAL AND KOROGEL: Plasticized polymerized vinyl chloride. Vinyl chloride is produced commercially by any of three methods: catalytic combination of acetylene and hydrogen chloride; chlorination of ethlyene to ethylene dichloride and partial dehydrohalogenation by treatment with alcoholic caustic; or by vapor-cracking ethylene dichloride.

The term "Koroseal" refers to a broad class of compositions having properties varying from those of hard rubber to those of a jellied cement. Korogel is highly plasticized Koroseal, and Korolac is a solution of Koroseal.

The physical and chemical properties of Koroseal may be varied over a wide range by the choice of plasticizer. With proper plasticizer it can be made transparent. The tensile strength varies from 1000 to 9000 pounds per square inch; flexing life, if used alone, is ten times that of natural rubber; tearing strength is equal to or slightly exceeds that of the best rubber compounds; and at atmospheric temperature resistance to abrasion is better than that of rubber. However, Koroseal is unsuitable for the manufacture of automobile tires, as it undergoes plastic flow at high temperatures.

The harder types of Koroseal are resistant to virtually all materials except organic compounds containing the nitro or chlorine groups, aliphatic or aromatic ketones, aromatic amino compounds, lacquer solvents, or acetic anhydride. Koroseal is resistant to corrosive chemicals, acids, alkalies, and water; it is not affected by sunlight, aging, oxygen, or ozone, and it is very superior in resistance to gas diffusion.

Koroseal is used in the manufacture of process equipment for chemical and allied industries, in pipe-line coating materials, balloon cloth, chemical tubing, vacuum and gas materials, electrical insulation, protective paints, belting, gaskets and packing, clothing and waterproof cloth such as wraps and shower curtains, upholstery, and for special uses in the cable and textile industries.

FLAMENOL: Plasticized polymerized vinyl chloride, is described as a synthetic compound resembling rubber, which serves both as an insulation and a finish for wire and cable. Its properties are said to include high dielectric strength, toughness, mechanical strength, stability in sunlight and oxygen, stability to ozone and oxidizing chemicals and to oils, solvents, acids, and alkalies, and resistance to flame and moisture.

POST-WAR RUBBER: The above lengthly but incomplete list presents an imposing array and still there are others and newer elastomers which have been announced, but about which there is little available information. All in all it seems that the country can rest assured that the rubber problem is being met.

Compressors used in a butadiene production unit

With this assurance many people in government and industry are turning their thoughts to rubber after the war. There are many important political and economic considerations which may develop natural rubber *vs.* synthetic elastomers into a major controversy, but ultimately the principles of supply and demand, of price and quality, that have influenced so many choices between products, will decide this issue.

One thing is certain. It is never safe to make predictions where a chemist is concerned. His ingeniousness and persistance in working with molecules and the fundamental laws of nature have often upset the best laid plans. Based on progress to date, chemists believe that there will come synthetic compositions which excel natural rubber in wear, resistance to deterioration, and other properties. In fact, many of these objectives have already been reached.

This does not mean that natural rubber cannot be improved. It undoubtedly will be. But the fact remains that the essential need for crude rubber, based solely upon superiority of its properties, is almost a thing of the past. The choice in a free world market will largely depend on cost and quality together.

It is generally believed that the price of synthetic elastomers might go down to between 10 and 15 cents per pound. Prices of natural rubber have fluctuated widely in the past. In 1910 an all-time high of $3.12 was reached. After World War I it dropped to 11¾ cents. Then a production control system was organized in the Far East and the price went to $1.21 in 1925. In 1932, during the depression, it dropped to 2.625 cents per pound. It might be said that the price of natural rubber ordinarily oculd be taken at 15 cents per pound. Prior to World War II it was fixed at 22½.

Some post-war plans advocate a return to the importation of rubber from its former sources and the development of new natural sources in this hemisphere. Fundamentally their argument is that this would provide jobs for the native populations and increase their standards of living If this is done it is logical that their wages would go up and if so it is a question whether the price of natural rubber, which is so dependent on cheap labor, could be kept lower than synthetic. Only time and technology can answer these questions.

⊕ ⊕ ⊕

PENICILLIN

New Chemotherapeutic Agent Holds Great Promise

A new antibacterial substance, penicillin, has joined the ranks of the "miracle drugs." Clinical tests of the new material give good reason for belief that it is superior to any of the sulfonamides in the treatment of *Staphylococcus aureous* infections, including acute and chronic osteomyelitis, cellulitis, carbuncles of the lip and face, pneumonia and empyema, infected wounds and burns. Preliminary tests on wounds and infections of soldiers returned from the battle-fronts have been so encouraging that the tests are going forward on a broad scale.

In this work many difficulties are encountered. They arise chiefly from the facts that the mold, *Penicillium notatum*, from which penicillin is obtained, produces only tiny amounts of anti-bacterial substances after a long period of growth in a culture medium that must be very carefully protected and controlled. According to a recent report, a yield of as much as one gram of purified penicillin from 20 liters of culture fluid would be an excellent result.

The chemical structure of the material is being intensively sought after. No conclusive results have yet been obtained but there are indications that the structure resembles that of a large class of aromatic or coal-tar chemicals. As soon as this chemical structure is determined, methods of synthesis and large-scale production will undoubtedly be developed.

Conducted by ALEXANDER KLEMIN

SINCE the first direct crossing of the Atlantic Ocean by airplane, made more than 20 years ago by Alcock and Brown, flying across the North Atlantic has been made commonplace by the Clippers of Pan-American Airways and American Export Airlines, the huge flying boats of the British Imperial Airways, and the cargo planes of the Air Transport Command. Bombers and even single-seater fighters are now being regularly ferried across the ocean, the fighters with the aid of droppable gasoline tanks to supply sufficient fuel for the crossing.

Floating Airports in Mid-Ocean

Reported Many Years Ago in these Pages, the Armstrong Seadrome is Now Assuming Added Importance in the Scheme of Things to Come in Aviation. Based on Sound Engineering Principles, the Seadrome Will Make Possible Over-Ocean Air Transportation with Land Type Planes

Most of this flying involves long jumps, sometimes of the order of 2000 miles; and for very fast de luxe passenger service of the future it will not be surprising to see non-stop operation between New York and London or Paris.

Armstrong (left) and Monro, with a model of the floating island airport

For less expensive passenger service, however, and for carrying air cargo or express, such long hops involve difficulties. A tremendous amount of fuel has to be carried because, in addition to the actual flight length, allowance has to be made for head winds, for possible loss of direction, for instrument approach, and for flying to an alternate airport. With high fuel loads, the actual payload (that is, passengers and cargo) is reduced to a small fraction of the gross weight of the airplane.

It is to meet this fundamental drawback of the airplane that there has once more come to light the idea of man-made islands to be moored in the North Atlantic for use as plane refueling stations. Invented by Edward R. Armstrong as far back as 1915, and lately developed and sponsored by such important corporations as the Sun Shipbuilding and Dry Dock Company, United States Steel Corporation, Worth Steel Company, Lukens Steel Company, Belmont Iron Works, General Electric Company, and John A. Roebling Sons Company, the Armstrong Seadrome has been patiently developed, step by step, and has now reached a point where far-sighted and hard-headed C. Bedell Monro, President of Pennsylvania-Central Airlines, has filed an application with the Civil Aeronautics Board for permission to connect eastern cities of the United States with Seadromes in the North Atlantic and thence with ports of air commerce to be designated by the Civil Aeronautics Board.

The sponsors of the Seadrome system state that these new bases will be made available to all companies and all nations that qualify. This is done so that the progress of post-war aviation will not be impeded and so that America can truly be said to be in a position of collaborator and not merely of competitor in trans-oceanic air travel.

Mr. Armstrong's long struggle for recognition of the Seadrome epitomizes the history of invention. During the long years of Seadrome development he has met every rebuff philosophically and has, with great continuity of purpose, kept on making new designs and new models.

The islands of steel, known as Seadromes, consist of a floating platform 70 feet above the ocean, with buoyant elements so far down as to give a draft of 160 to 180 feet. No matter how rough the ocean may be, these elements make the Seadrome as steady as the mainland itself. Experiments made in a test basin with artificially created waves have given ample proof of the accuracy of this statement. To those who immediately visualize a huge steamship being tossed about in waves, the idea at first appears fantastic. Yet it is based upon sound principles of physics and extensive study of wave motion.

The ocean is destructive only when it is opposed, as near the coast. In mid-Atlantic, vast rollers become harmless, particularly when allowed to travel through an open truss work as in the Seadrome structure. But to explain why the Seadrome remains level, despite ocean roughness we must go to other facts of natural philosophy. The trochoidal wave of the surface of the sea has its companion form below, but the height of the wave formation decreases rapidly below the surface. At 30 feet below, the wave motion is scarcely perceptible. Therefore, the buoyancy elements and the ballast elements of the Seadrome are placed well below the surface. The diagram shows a 1500 foot Seadrome in waves 600 feet in length and 30 feet in height. As the waves pass, the buoyancy varies slightly from flotation element to flotation element, but the sum of the buoyancies remain constant. Since the total buoyancy is constant, the Seadrome neither rises nor falls with the waves.

Because of this constancy of buoyancy, because the wave motion almost disappears at depth, and because the power of the ocean is not challenged, the design of the Seadrome is reduced to a problem in civil engineering not dissimilar to that of bridge construction. The design of the Seadrome now under construction has been approved with a *A-1 rating by the American Bureau of Shipping.

THE FLOATING airport will have a total displacement of over 100,000 tons and its landing deck will be 70 feet above sea level. The structure will be 3550 feet in length, 400 feet wide at the center, and 280 feet wide at the ends—ample dimensions for taking care of large transports and capable of handling with ease an airplane of some 100,000 pounds gross weight, or possibly more. Auxiliary power sources and six electrically actuated propulsion units will deliver a thrust of 300,000 pounds—sufficient to maintain the Seadrome on station, even if the anchorage gear should fail.

The deck will be supported by 72 buoyancy tanks connected to it by

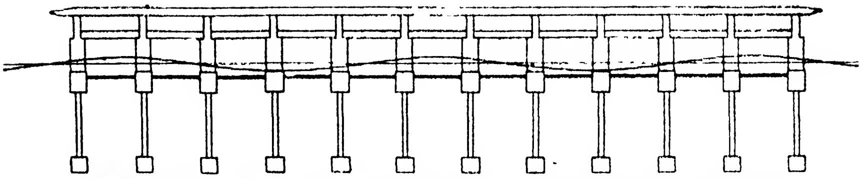
Platform of the Seadrome, showing the hotel and parking facilities

means of streamlined steel and iron columns. The whole will form a deep truss composed of tubular struts and steel cable ties encased in iron pipes. Iron will be used because research has shown that iron, while not as strong as steel, provides greater protection against corrosion. The tanks will be arranged symmetrically in three rows of 24 each, with longitudinal spacing of 150 feet. The lower columns extend to about 110 feet below the buoyancy tanks to support the ballast tanks. These contain sufficient ballast to lower the center of gravity of the structure to about eight feet below the center of buoyancy, another reason for the extreme stability of the structure.

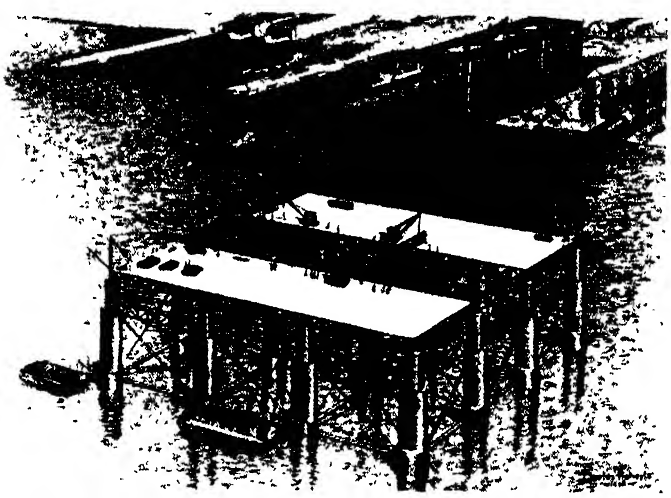
All exposed parts of the Seadrome in the region of the water line and above it will be of streamlined shape to reduce head resistance to a minimum. The lower columns will be circular in cross-section so that they may be uni-directional in water currents.

The deep-sea draft of the Seadrome on station duty will be 165 feet. Obviously such great draft precludes erection close to the shore. Therefore, in order to make construction possible in shallow water, the ballast tanks are designed to telescope into the streamlined upper columns during erection. Decks and bulkheads will divide the tanks into 12 watertight compartments. There will be bilge pumps and air pumps, as in a steamship.

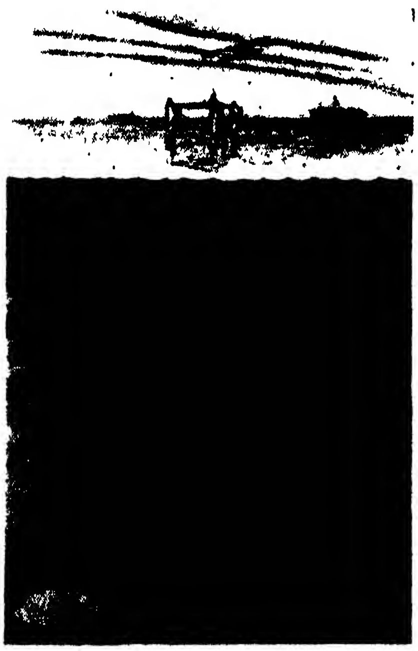
The Seadrome will be able to develop some forward speed, as previously stated, and its six screws will head it into the wind, as required for airplane operation, making a 90 degree turn in from 10 to 15 minutes. With this built-in means of propulsion, the problem of towing the Seadrome into position should be a relatively simple one. But to those who know how difficult it is to anchor even a lightship of 1000 tons in relatively shallow water, and how frequently lightships tear from their moorings, it may at first appear impossible to anchor a structure of 100,000 tons in the deep waters of the Atlantic, for if a ship of this size were to be moored in mid-ocean, wind and wave would indeed make the task impossible. But the Seadrome will not pitch, roll, or heave at it's anchor, and, because of its constant buoyancy, the open-work structure will offer the least resistance to the motion of the water, while the upper above-water structure is streamlined. As a result, the natural forces acting on the Seadrome are reduced to a minimum.



How a 1500-foot Seadrome would remain level in 600- by 30-foot waves



The Seadrome will be built in sections, with the ballast tanks telescoped into upper columns, and then towed to sea



How the anchors of the Seadrome will rest on the bottom and hold the steel structure in place by means of bridge cables, with chains at lower end

It is, however, necessary to guard against air forces reaching a velocity as high as 70 miles an hour. From Seadrome tests made in the New York University wind tunnel and carried out by the writer of this article, a total anchorage pull of only 600,000 pounds is anticipated. With a factor of safety of 3½ included in the stress total, this would require the unheard-of wind speed of 140 miles an hour to break a Seadrome loose from its anchorage.

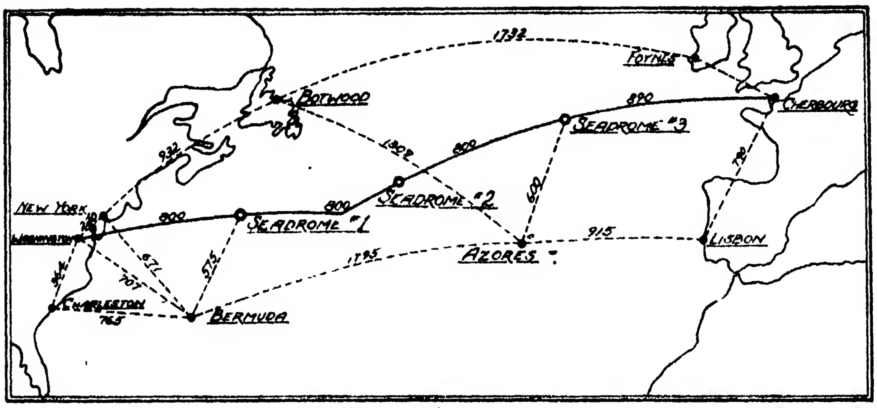
Yet even 600,000 pounds is no small pull. The Seadrome is to be anchored in mid-Atlantic where the depth of the ocean may be from two to three miles. It becomes impossible to use link chain, such as is ordinarily used with ships. The very best forged alloy steel chains would break from their own weight before they reached the bottom of the ocean at approximately 13,000 feet. Suspension bridge cables, on the other hand, have ample strength to reach a depth of 60,000 feet, which is very considerably beyond the distance to the bottom of the deepest ocean. But cable must not be allowed to rub on the ocean bottom. For this reason, the anchorage cables will be slightly shorter than required for a given mooring and then will be extended at their lower ends by forged alloy steel chains which, in turn, will be attached to the anchor. The anchor chains then will take up the wear and tear on the bottom. They should be able to withstand this for some 20 to 30 years.

The Seadrome anchors, which function by friction, must weigh more than 1000 tons each. They will be equipped with flotation chambers and so designed as to be built on a shipway, launched when completed, and then towed to position and sunk.

The facilities and equipment of the Seadrome, though placed in unconventional surroundings, are to be quite conventional in character. There will be a luxurious hotel, located at the side of the main platform so as not to interfere with the operation of aircraft. There will be ample arrangements for refueling and servicing of aircraft. A complete radio station and an equally complete weather bureau will be located on the structure. In general, the Seadrome will be a combination of an airport terminal and a luxurious summer sea hotel. It should be fascinating to spend a brief vacation in mid-Atlantic.

It is of interest to study the sketch map of the North Atlantic. The Seadromes will be moored 800 nautical miles apart and will be out of the region of fog and ice. Compare this distance with that between Botwood, in Newfoundland, and Foynes, in Ireland, which is 1732 nautical miles, and that between Bermuda and the Azores, which is 1795 miles. To fly the Seadrome route from Washington to Cherbourg means only 3200 miles in four hops of 800 miles each. Alternatively, Charleston to Bermuda is 765 miles, Bermuda to the Azores 1795 miles, the Azores to Lisbon 915 miles, and Lisbon to Cherbourg 798 miles, giving a grand total of 4273 nautical miles.

We cannot here enter into a detailed technical discussion of the economic advantages of the Seadrome, but the essence is as follows: An airplane weighing 25,000 pounds, undertaking a non-stop flight of some 500 miles, can carry a payload of 5000 pounds at a cost of 10 to 12 cents per ton mile. If, however, the length of the trip non-stop is 1500 miles, the payload may thereby be cut to 2000 pounds and the



Non-stop, island-stop, and Seadrome routes across the Atlantic

cost per ton mile then becomes 25 to 30 cents, which is prohibitive.

It is quite true that much larger airplanes, machines equipped with four 2000-horsepower engines and with a gross weight of around 100,000 pounds, can carry a larger percentage of payload, undertake longer trips, and have lower direct flying cost per ton mile. Nevertheless, even for the largest and best cargo airplane, the principle remains the same. The longer the non-stop flight, the less the payload, and the more costly the operation.

For very fast, de luxe traffic across the Atlantic, non-stop flight is feasible. The post-war business man of vast responsibilities, who wishes to spend a day in London and come back with minimum loss of time, will fly on a fast airplane which will bring him to Europe non-stop in a matter of 12 hours or so. The fare may be $500 or more, but cost will be of small importance. Such a fare would be out of the question, however, for the ordinary traveler or vacationist, but by reducing flight length and decreasing cost per ton mile, the Seadrome would make it possible to charge as little as $150 for a one-way ticket to Europe. An immense increase in air passenger travel would follow.

Again, instead of paying 60 cents for an air mail letter to England, we would pay 5 or 10 cents at most. An enormous increase in air mail would follow.

For freight and cargo, the steamship will probably remain supreme for many years to come. Where costs per ton mile are counted in cents for the airplane, they are counted only in mills per ton mile for the steamship. No aircraft, even with the use of Seadrome facilities, can begin to equal the cargo-carrying capacity of a large steamship. But as airplane operational costs go down, the possibility of increasing the amount of some classes of air express is clearly indicated.

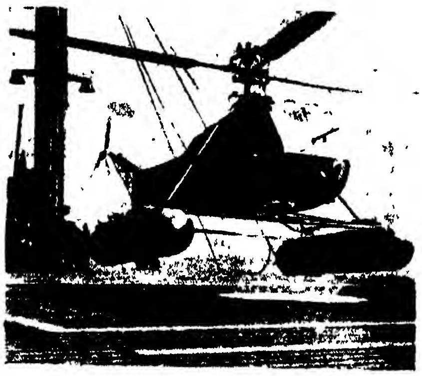
The cost of constructing a Seadrome and getting it on station is expected to be around $12,500,000. Operating costs for three seadromes would be approximately $500,000 annually, and maintenance costs should not be high.

● ● ●

ANTI-SUB HELICOPTERS

Have Demonstrated Ability to Use Ship's Deck for Landings

SEVERAL years ago the use of helicopters for convoy work was advocated in Scientific American. Now the remarkable accompanying photograph shows the landing of a Sikorsky helicopter on the deck of a Maritime Commission tanker, with the craft hovering over the deck just before landing. In the process of the trials, the rotating wing aircraft made 24 landings and take-offs from the deck of the tanker. This was the first time that a helicopter had ever been landed on or flown from a ship deck, and the first time that there had been performed a ship-to-ship ferry flight by helicopter. The take-off space on the deck of the tanker was only 78 by 48 feet, closed in fore and aft by deck housing superstructure and mast. Flotation equipment on the helicopter made it possible to take off and land on water as well as on board the ship and the Sikorsky helicopter showed its usual flexibility and precision. In the opinion of the War Department, the advisability of using the helicopter as a weapon against the submarine has been fully demonstrated.



A helicopter lands on deck

ENGINE MATERIALS

Can be Improved by Application of New Preparation Methods

THE aircraft engine of 1943 weighs only only about half as much per horsepower as did the engine of World War I. This decrease in specific weight per horsepower is due primarily to improvement in fuels, increase in engine speed, and general improvement in engine design, but the basic useful strength of the materials employed has not been greatly altered.

There is, however, a great deal to be done in increasing "fatigue strength" of many machine parts. It is not mere stress that causes breakdown of engine parts but fatigue, since alternating cycles of stress occur hundreds of thousands of times. J. O. Almen, of the Research Laboratories of General Motors, in a paper entitled "Shotblasting to Increase Fatigue Resistance," read before the Society of Automobile Engineers, brings us some entirely new concepts of fatigue resistance, Mr. Almen says that the fatigue strength of the most carefully prepared specimen is increased if a thin layer of the specimen is pre-stressed in compression by being hammered, swaged, or shotblasted, or subjected to pressure by balls or rollers. The new process deserves careful attention by our aircraft engine constructors, and has further implications in many other industries.

ENGINE RUGGEDNESS

Demonstrated by Bullet-Drilled Valve Stem

JAP Zeros may be excellent in maneuvers, remarkably fast on the climb and, on the whole, not bad fighting ships, but they cannot take it; they literally explode when caught in the fire of one of our carrier-based fighters. It is not too much to say, on the other hand, that our aircraft and our aircraft engines lead the world in ruggedness and reliability. The photograph of a Thompson Products valve from a Wright Cyclone engine, with a quarter-inch bullet hole through the valve stem, proves our point. The Wright Cyclone was in use in an American-built Curtiss Mohawk (75-A) fighter in the Far East When the quarter-inch bullet pierced it, the valve stem should have broken instantly and wrecked both engine and airplane, but, as a mater of fact, the engine functioned perfectly for 110 flight hours and went through a dogfight. Ordinarily a valve of the sodium type, when the sodium is shot out of it, should burn and cause trouble. But even though the cooling sodium had run out through the bullet hole, the stem with its superfine steel structure continued functioning.

Pierced . . . but still functioned

Dyes Will Be Even Better

Freed by Intensive Research from Dependency on Foreign Sources, the American Dyes Industry is Now Contributing Largely to the Development of All Branches of the Chemical Industry. After the War it Will Be Producing New and Improved Products for Peacetime Consumption

DR. J. H. SACHS
E. I. du Pont de Nemours and Company

ONE hundred and forty years after the Declaration of Independence of 1776, another declaration of independence was proclaimed to these United States, leading to freedom from reliance on Europe for dyes and other organic chemicals.

By 1916 Germany had been blockaded and shut off from overseas commerce for two years. Up to that time America had been almost wholly dependent upon this foreign source for the dyes and other chemicals essential to the great textile industry of the United States.

In 1916, evidences of our lack of good dyes were numerous. The housewife complained about the difficulty in obtaining the multi-colored fabrics to which she was accustomed. What colored materials she was able to purchase proved to be poorly dyed. Never was fading of fabric colors so pronounced as in the years of the last war. Our entry into the conflict in 1917 accentuated this deficiency in quality dyes. The color of the Yanks' uniforms depended upon how many times they had been washed. Indeed, it was the privilege and habit of the recruit in World War I to give his new uniform a severe scrubbing to remove much of the khaki color and make him appear to be a veteran.

It was during those critical days that America declared its second independence and started to develop its own dyes industry. Certain American chemical manufacturers, encouraged by the textile industry which had been so badly disrupted by the lack of essential materials, decided to enter the field. They learned at once that the establishment of a dyes industry offered little in volume of business. America's total dyestuffs bill at that time amounted only to approximately 25 cents per person per year. Thus a potential thirty million dollar business would necessitate research expenditures running into millions of dollars before any actual production started. The dyes industry, furthermore, was not made up of a mere 10 or 20 products, but of literally thousands. Each color, though sold only in relatively small quantities, had a definite place in leather, paper, or textiles. Mass-production methods were not adaptable to the synthesis of dyes and chemicals in closely related fields.

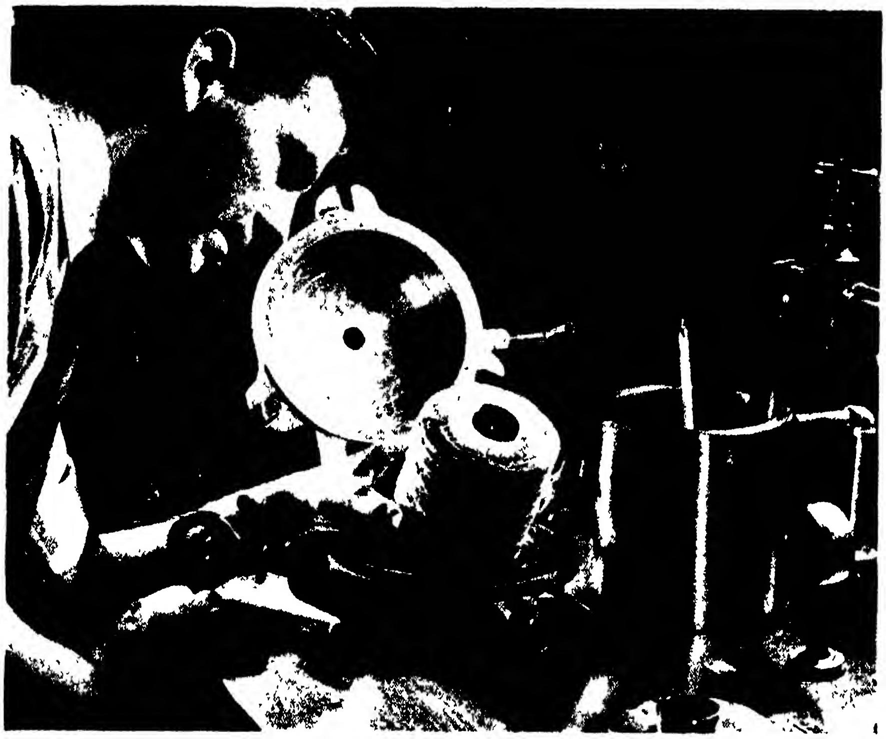
The few colors and related products—such as medicinals and perfumes—which were made in America before 1916 were largely derived or manufactured from chemicals imported from Europe. It was necessary, therefore, to build an American dyes industry from the ground up. The foundations lay deep within the iron and steel industry, for in the coal tar derived from the by-product coke ovens of this industry are found the five essential materials from which all synthetic dyestuffs are made—benzene, toluene, xylene, naphthalene, and anthracene.

Coloring matters as such do not exist in coal tar, but from these five materials, derived from coal tar, dyes are made by various combinations of the essentials. For example, aniline is made from benzene, while beta-naphthol is derived from naphthalene. A combination of aniline and beta-naphthol gives a dye. These five materials can best be likened to five different kinds of clay, from each of which can be made a great variety of bricks. "Bricks" made from benzene, toluene, and the others are arranged pattern-wise into thousands of possible combinations, each combination representing an individual so-called coal-tar dyestuff.

The years 1916-1920 witnessed the first real production of American colors. These initial colors were the simplest and, generally, the least fast. Better and more complicated dyes came later. Progress was gradual. More complicated colors were first studied in the research laboratory, subsequently made in semi-scale plant equipment to prove the laboratory process, and finally produced in full-scale plant equipment. By 1919-20 the first of the anthraquinone vat dyestuffs, the fastest known colors, were produced on a limited scale.

The financial depression of 1921 ruined some firms, but did not halt research and development of dyes and related chemicals. By 1925 it could be said that America possessed an organic chemical industry. Compounds used in the petroleum, rubber, and numerous other indutries were developed as the result of dyes research. Taking synthetic indigo as a measuring stick, Table 1 clearly shows how this

Laboratory equipment for converting water-soluble dyes into insoluble pigments. Dyes are employed to a large extent in printing inks, paints, varnishes, and so on



Much yarn is dyed in what are known as "packages." These are steel bobbins wound with yarn which are placed over circular tubes in a cylindrical machine and the cover bolted in place. The dye liquor is pumped through the tubes and forced out through the yarn. Shown is a laboratory package dyeing machine which is, in every respect, a small-scale duplicate of its counterpart used in commercial production

country achieved chemical independence.

The selling prices of dyetuffs declined as production increased. In 1918 indigo sold for 88 cents a pound, in 1920 for 74 cents a pound, in 1922 for 24 cents a pound, and in 1925 for 16 cents a pound. The year 1920 was the last in which the sales value per pound of domestic dyes averaged in excess of $1.00 per pound. The average value

Table No. 1

Year	Pounds of synthetic indigo domestically produced
1914	None
1918	3,083,888
1920	18,178,231
1922	16,108,020
1925	24,449,938
1930	24,326,403
1940	11,009,307

in 1920 was $1.07 per pound, while by 1930 it had dropped to approximately 43 cents. This reduction was achieved despite the fact that from 1920 to 1930 the production of the more expensive anthraquinone and thioindigo vat colors increased tremendously. Comparative data on total production of these fast vat colors, costs, and sales values are available from 1925, as is indicated in Table 2.

Actually, the weighted average price per pound of domestic dyes increased between 1930 and 1940. Selling prices of individual colors did not advance, but there was a greatly increased use of the better and more expensive dyes—anthraquinone vat colors. These were the dyes which the Germans believed to be their very own in 1916. They boasted that no other country possessed the chemical skill to produce them, that they had no fear of American encroachment. Today we manufacture over two million pounds per month of anthraquinone vat dyestuffs, these vat colors now being used almost exclusively in the dyeing of cotton uniform cloth.

Gradually over the years United States imports of foreign dyestuffs have decreased so much that in 1938, the last full year prior to the outbreak of war, they amounted to less than 20 percent of the value of all dyes sold in this country. During these same years our dyes were being used all over the world in constantly increasing quantities.

American dyes today are the equal of or superior to any in the world. This quality is ever being improved. What was considered the fastest color in 1920 has since been immensely improved upon. Colors of unprecedented fastness have been developed and manufactured. New colors often are more expensive, but consumers long ago learned that the purchase of a poorly dyed fabric constitutes an economic waste. The few cents additional cost of a fast-dyed fabric is worth many times the small difference.

One color in particular is outstanding among all others—Anthraquinone Vat Khaki 2G. It is so important to the military that the production of this color alone is more than 30 times greater than before the war, and manufacturing capacity is being further increased.

Table 3 illustrates the complexity of this particular color. In this table are given the chemical formulas, as the dye chemist writes them, of benzene, naphthalene, and anthracene. Also given are the formulas of indigo which, with aniline as the intermediate product, is derived from benzene; of Thio Indigo Brown G which, with thio-beta-naphthol as the intermediate product, is derived from naphthalene; and of Anthraquinone Vat Khaki 2G which, with anthraquinone as the intermediate product, is derived from anthracene.

Of course, the layman will be unable to carry such formulas in mind, but a survey of them will give him an idea of what it takes to produce the basic color used to dye the cotton cloth for soldiers' uniforms.

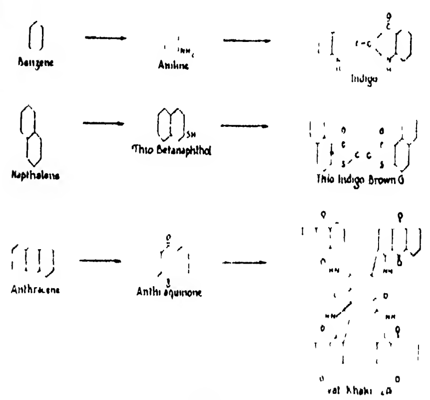


Table 3

Another one of the anthraquinone vat colors used in increasingly large amounts for the dyeing of OD shades on uniform cloth is a product of the inventiveness and ingenuity of the American dyestuff chemist. In fact, there are at least a dozen anthraquinone colors which have been discovered by our chemists as new chemical identities. Some are used in relatively small quantities for special purposes; others in quantities running into the thousands of pounds per month.

The quantity of fast colors available to civilians now and for the duration is governed completely by the military. Like many other commodities—steel, gasoline, coal, for example—dyes are needed in record quantities for essential purposes. What colors are portioned for civilian fabrics changes almost from day to day. So far there have been substantial quantities of fast dyes for civilian textiles, but the requirements and supplies for the months ahead are not easily predicted.

Table No. 2

Year	Domestic Production	Sales of Domestic Production	Total Value of Domestic Sales	Value per Pound of Domestic Sales
1925	86,345,438 lbs.	79,303,451 lbs.	$37,468,332	$ .47
1930	86,480,000 lbs.	89,971,599 lbs.	38,621,610	.43
1935	101,933,000 lbs.	97,954,000 lbs.	51,488,000	.52
1940	127,834,000 lbs.	122,877,000 lbs.	76,432,000	.62

Do you know the two big differences between the JAPS and the CHINESE?

Anthropologists who have carefully studied the *physical* characteristics of the Japs and the Chinese say they have been unable to produce a sure guide for distinguishing between the two. They say some Japanese look like some Chinese and vice versa.

But there are two big differences between them that are of far greater importance to Americans than skin color, set of the eyes or facial shape:

Difference No. 1. The Japs are our enemies; the Chinese are our friends.

Difference No. 2. The Japs have a modern industrial organization for turning out the weapons of war. By comparison, the Chinese have little in the line of industrial equipment.

Thus we find the Japanese soldier attacking China well supplied with planes, artillery, tanks and other modern equipment. His opponent, the Chinese soldier, is armed with magnificent courage, determination and belief in democracy—but is short of arms and ammunition.

Today it is up to the industries of America to help remove this great handicap. Americans must supply the guns and planes and bombs and gasoline the Chinese cannot make for themselves . . . materials they will gladly use to kill Japanese.

Remember: a Jap killed by the Chinese is one less Jap for Americans to take care of.

Among the many materials needed in today's mechanized warfare is Ethyl antiknock fluid, which is used in high-octane military gasolines. The 4000 people engaged in manufacturing Ethyl fluid are making enough to supply not only our own armed forces, but those of our Allies as well. They know that today "Every drop of Ethyl counts."

ETHYL CORPORATION
Chrysler Building, New York City

Manufacturer of Ethyl fluid, used by oil refiners to improve the antiknock quality of aviation and motor gasoline

The establishment of an American dyestuff industry has had numerous repercussions in other lines. Naturally, such an industry requires a nucleus of highly trained personnel, a personnel schooled in both research, production, and engineering. Chemists and engineers trained in dyes have expanded their research activities to discover and develop related products, and others have contributed to all branches of the diversified chemical industry.

Synthetic camphor is an example of a product developed by these men. For many years the world depended entirely upon Japan for its camphor supply. Today the United States is manufacturing its own camphor requirements with a process developed by men who were primarily dyes chemists. Neoprene, the first synthetic rubber to be produced in America, and a product which has assumed tremendous importance in our war economy, was likewise developed and manufactured by men whose primary business was the manufacture of dyes. The first pound of sulfanilamide produced in America was made in the research laboratory of one of our largest dyes manufacturers, and production of sulfa drugs today is being carried out largely by a leading dyes manufacturer.

Every dyes chemist and engineer, whatever branch of the industry he serves, is busy today. Some are helping make record quantities of synthetic rubber, high-octane gasoline, and other war necessities. Others are doing confidential research for the government And still others are manning the great new military explosives plants. Had not a dyes industry been founded here in 1916, we would not have had the synthetics so vital to our war effort, nor the personnel to make them.

After the war, all these chemists and engineers will be available for peacetime research and development. They will then produce new and even better dyes and new and better synthetics to enhance our standard of living.

⊕ ⊕ ⊕

FAST PHOTOS

Enable Research Scientists to Study Explosives

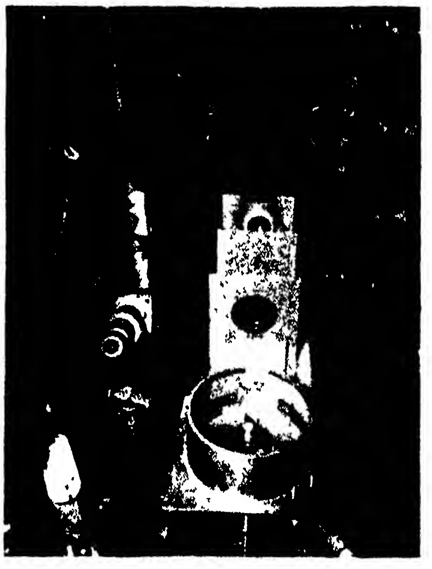
Two of the world's fastest high-speed cameras are being used to photograph the detonation waves of explosions, which travel 5 to 25 times as fast as sound. These cameras record explosions of one-kilogram charges that are about six inches long, and a "slow" explosion is one that lasts about one hundred millionths of a second.

Perfected by Dr. Robert W. Cairns, a physical chemist who is now director of the Hercules Experiment Station, one of these units, called the rotating drum camera, has been in use more than five years. It is fast-moving enough to record all details of the lightning-quick activity when an explosion detonates.

Although the rotating drum camera is sufficiently fast to photograph the detonation wave of any explosive, a second camera, ten times as fast—called the rotating mirror camera—has recently been perfected to photograph highly-refined measurements.

With these cameras, explosives experts can see exactly what happens during detonation, and also what took place at every instant during the explosion, even down to "instants" as short as one ten millionth of a second. Findings based on this research photography are invaluable in the study of the behavior of various types of explosives.

A comparatively "slow" explosive, for instance, is a grade of dynamite used in coal mining to prevent pulverizing the coal, whereas certain military explosives



should be rapid-detonating to secure maximum destruction of enemy ships, tanks, and installations.

The Hercules cameras are set in a special explosion-proof shelter on the grounds of the chemical company's main laboratories outside Wilmington. Inside the shelter is the explosion chamber, about the size of a small room. The walls of the shelter are two feet thick and of reinforced concrete. A narrow passageway winds around the interior, with three right-angle turns, to attenuate the noise of the explosion, and also to keep out daylight. The camera itself is mounted inside a steel box made from heavy angle iron and steel plates.

To photograph an explosion, experts suspend the cartridge of dynamite, TNT, nitroglycerin, or other high explosive to be detonated, by wire from the ceiling of the chamber. The cartridge hangs one to two yards from the lens of the camera, which is protected by a standard automobile type safety glass window.

From another building, the cartridge is detonated by means of an electric switch. Elaborate safety devices prevent firing of the charge until everyone is out of the danger zone. The flash of light instantaneously produced by detonation of the explosive is the only light in the sealed chamber. The film recording the progress of the explosion is actually a photograph that shows the details of the light flash, its movement and duration.

The explosive charge is loaded in transparent tubes of glass or of cellulose acetate plastic, to enable the

Left: **Double lens system of new camera for high-speed photography.** *Above:* **The assembled camera.** *A* **is lens,** *B* **the cover,** *C* **the adjusting screw,** *D* **electric lines to motor,** *E* **connection to vacuum pump**

camera to record the action of the explosive grains within the tube.

Although an explosion sounds like a simultaneous blast of the entire charge, the camera shows that the detonation wave actually travels consecutively from grain to grain, up the middle of the cartridge from the end at which it is detonated by a blasting cap.

So swiftly does the detonation wave travel along the cartridge that the detonation is substantially complete before the plastic tube has been shattered by its force

Films taken of the detonation of various types of explosives show a wide range of detonation velocities. Nitroglycerin detonated in a glass tube has been recorded at a velocity of detonation of 300 miles a minute, or 25,600 feet a second, which is approximately 25 times the speed of a sound wave.

Dynamite for coal mining, on the other hand, often is only a fifth as fast.

But even with a "slow" explosive, the detonation has been completed before the sound of the blast reaches human ears.

Detonations of high explosives that occur within only a few millionths of a second are among the most rapid actions that have been measured. One of the fastest known to the layman is the blinking of an eye, which medical scientists have measured in hundredths of a second. Detonation waves of explosions travel 10,000 times faster.

RHENIUM

Now Available To Researchers From a Domestic Source

For the first time since its discovery in 1925 by Ida Eva Noddack and Walter Karl Friedrich Noddack, German chemists, the extremely rare metal rhenium has been extracted from a domestic ore by-product. Discovery of the American source and a satisfactory method for the recovery of the metal therefrom is announced by A. D. Melaven and

J. A. Bacon of the Department of Chemistry, of the University of Tennessee, at Knoxville.

The source material from which the rhenium has been extracted is a flue dust obtained from the roasting of a molybdenum ore mined in the western United States. The rhenium, occurring to the extent of a few parts per million in the original ore, is concentrated to the extent that the flue dust by-product from the roasting operation contains from 10,000 to 15,000 parts per million of the metal, the roasting operation at the same time converting the metal to a soluble compound form.

The recovery of rhenium in the form of one of its pure compounds is accomplished in three relatively simple steps. The flue dust is first treated with water to remove the soluble compound of rhenium from the insoluble materials. The water extract is then treated chemically to effect precipitation of the metal in the form of potassium perrhenate.

The product of this precipitation contains approximately 30 percent of the metal by weight. Final purification of the potassium perrhenate is accomplished by subjecting the crude material to a series of washings and reprecipitations. The free metal may be obtained from this pure compound by one of several available methods.

Prior to the work by the University of Tennessee chemists, all of the rhenium sold in the United States was imported from Germany. Since the outbreak of present hostilities, available supplies of rhenium for research and other purposes in this country dwindled to the point of virtual non-existence.

The metal rhenium, while having unique properties of its own, bears some resemblance in physical properties and chemical behavior to the more familiar molybdenum, tungsten, and manganese. Its high melting point among metals is exceeded only by that of tungsten, and its density, greater than that of gold, is exceeded only by platinum, iridium, and osmium.

Being a relatively recent addition to the list of chemical elements, its potentialities as a material of future industrial and economic importance have not been fully exploited. However, research on the element with the view of finding important uses for its unique properties is underway in several laboratories.

TOOL CARE

Speeds Industrial Production, Places Responsibility

Good housekeeping as far as the care of tools is concerned, as shown by the accompanying photograph of a cutter cabinet inside a tool crib at the General Electric plant in Philadelphia, is helping speed war production in many American war plants.

One of the most successful tool practices is the crib system which classifies tools and equipment used in the shops. Under this system, employees are responsible for the tools that they use.

Some tools may be kept for an indefinite period, while others must be turned in at the end of the shift so that workers on the following shifts may

Good housekeeping speeds production

have the use of them. Many of the tool cribs are equipped to repair worn or damaged tools. Tool crib stocks are replenished from central tool crib stock rooms. Special metal boxes, each marked with the number of the tool crib from which it came, are provided for delivery of tools and equipment from the central stock to the individual tool cribs.

BOMBER CEILING

Boosted by New Generator Brushes

A new chemical development that enables American bombers to fly higher into the sub-stratosphere and stay there longer increases by 50 times the high-altitude life of carbon brushes for airplane generators. The brushes were developed by Dr. Howard M. Elsey, research chemist at Westinghouse, and have been made available to all companies producing air force generators.

Brushes are the bars of carbon which pick up power from the generators and relay it to the plane's electrical system. If they fail, and the batteries are drained, a bombing plane's radio, radio compass, landing gear, lights, and other vital auxiliaries cannot operate.

Research Chemist Elsey, who developed new 'plane generator brushes

"Generators equipped with treated brushes," Dr. Elsey says "are now able to deliver electric power at normal capacity for 100 hours or more above 30,000 feet. Untreated brushes wear out in an average of two hours and they may fail in a few minutes if the generator is called upon to deliver large amounts of power."

The new brush development simplified the problem of providing electric power to pump air into a sealed bomber cabin, keeping the crew alive at altitudes around 40,000 feet. Without the new high-altitude brushes, pressurized cabin planes would have to carry more or larger generators to insure enough power for the pressurizing pumps. This added load would hold down their ceiling.

Dr. Elsey's process involves impregnating the porous carbon with a chemical ingredient that becomes a lubricant when the brushes are pressed against the revolving copper commutator by strong springs. This ingredient puts a film on the copper to lessen friction that rasps ordinary brushes into powder at altitudes above 25,000 feet. The chemical itself is being held a close military secret.

"Untreated brushes," he explained, "were satisfactory for low-altitude flying but beyond 25,000 feet under 'fighting' electrical loads they disintegrated into dust in a few hours. This limited high-altitude flights, endangered trained crews and valuable ships, and necessitated frequent 'time out' from flying for brush replacement."

SPONGE RUBBER

Substitute Derived from Linoleic Acid

A major research contribution to the war effort is in the form of an urgently needed substitute for sponge rubber made of linoleic acid, a derivative of vegetable oils, developed in the Research Laboratories of Bauer and Black

The sponge product can be made in any thickness and in varying densities. It has a useful property of vulcanizing directly to many surfaces such as metals and plastics and it has flex-cracking resistance which improves at lower temperatures—the direct opposite of sponge rubber made from natural rubber. In many other respects the properties of the new substitute are so close to those of rubber that they appear identical.

PATTERNED GLASS

Diffuses Light, is Decorative, Has Many Uses

Flat glass sheets that are now being made in 12 distinctive patterns have a wide potential use in many places where plain glass is now used and in places where it will replace other materials with greater satisfaction or utility.

These glass sheets, available in tempered form, are so patterned as to diffuse light and to give a variety of appearance. They are being used in partition doors and sections, for shelving

and shower stalls, for windows and change plates in cashier's booths, for oven lining and shelving, as sludge plates in sewage disposal plants, in connection with built-in lighting fixtures, and so on.

"DISTILLED" WATER

Produced Chemically for Industrial Applications

PRODUCING mineral-free water by an entirely chemical treatment is one of the recent developments in the science of water conditioning. The age-old method of producing distilled water was to boil off the water, leaving the minerals. This method required huge stills and tremendous quantities of heat. The new Permutit "demineralizing" process requires merely passing water through beds of chemicals to remove the harmful minerals, producing "distilled" water at a cost often as low as 5 percent of the cost of distillation. The importance of this process is indicated by the fact that today's war industries require tons of such purified water.

In the "demineralizing" process two steps are required to produce synthetic distilled water. In the first step, calcium, magnesium, and sodium ions in tap water are removed by "ion-exchange" zeolites. The second step involves absorption of the resulting acids formed in the first step. The final water is suited for industrial processes, boiler feed water, manufacturing, and so on

"Demineralizing" has proved applicable to storage batteries, alcohol deproofing, brewing, preparation of photographic film, soda water, and other consumer products. Adaptations of the process have also found special applications, such as purifying sugar and increasing yields from sugar cane, purifying gelatin, recovering metal from industrial wastes, and so on.

POST-WAR HOMES

Will be Cheaper, Better, Because of Science

THE American who plans a post-war home, the architect who designs, and the builder who constructs it, stand on the threshold of an exciting adventure, in the opinion of E. B. Alvord, head of the Specialty Chemical Section of the Du Pont Company's Grasselli Chemicals Department.

His vision of tomorrow's home, shaped out of newly-developed materials which have been severely tested in the crucible of war, is a challenging picture.

The house of the future will almost certainly be made of standardized, mass-produced parts. Owner and architect will assemble the parts in any shape and form desired. Such a home will be enormously cheaper than those of today —estimated by some authorities at $500 to $800 per room.

It was reported that plywood adhesives recently perfected for the aviation industry will be available after the war in great quantities. Thin sheets of "veneer," or ply, bonded with these new glues, can be bent or molded into practically any shape desired. Plywood furniture, bathtubs, light walls, and movable partitions as strong per unit of weight as steel will go far toward making possible the inexpensive and durable house of tomorrow.

"Take wood, for example," says Mr. Alvord. "Chemical science is capable of endowing wood with qualities that vastly improve upon Nature. Retaining all its inherent advantages for construction—workability, economy, low heat conductivity, and ease of replacement—the chemist can supply the post-war building industry with lumber treated so as to be a distinctive structural material in its own right.

"In the chemical transformation of wood," says Mr. Alvord, "another substance known as crystal urea shows great promise. Green woods, impregnated with urea and dried, become relatively plastic when heated. They may be bent, twisted, and compressed. They retain their new shapes, resuming their normal rigidity and hardness, when cool.

"Plastics formulated from cellulose, the skeleton, so to speak, of trees, and from other sources, will be used widely by the building and furnishing industries. Everything from luminous light switches to decorative pieces are predictable.

"There have been significant wartime advances in finishes technology that will be adaptable to the beautification and protection of peacetime dwellings. Finishes research lately has been producing

'tailor-made' particles to give paints special characteristics for special uses.

"Air-conditioning will eventually become as standard a part of the American home as the cook stove," Mr. Alvord points out. "The very same safe refrigerant that you may have today in your present refrigerator is being manufactured in quantities far exceeding pre-war needs."

CONVEYOR BELTS

Being Used at Highest Earthen Dam

WITH resumption of work on giant Anderson Ranch Dam in the south fork of the Boise River, Idaho, conveyor belts will become the main haulage system for the first time in construction of an earthen barrier. Nearly 30,000 feet of belts supplied by the Goodyear Tire and Rubber Company will be used to handle most of the 12 million cubic yards of clay and other types of soil needed for this, the highest earthen dam in the world.

Supplementing another flood control and irrigation dam further down the river, the Anderson Ranch Dam will be 444 feet high above its foundations and 350 feet above the stream bed. Its construction is expected to require several years. The river's flow is being diverted through a 1600-foot tunnel, 20 feet in diameter, until the dam is completed.

One of the nine long conveyor belts in use at a western dam

Nine flights of belts in 36-inch widths will carry impervious clay for the core of the dam from a borrow pit a mile and a half away. Several 60-inch belts will help provide the pervious material for the exterior from another borrow pit.

In this belt-conveyor project are included all the Goodyear developments

worked out for other projects such as the 10-mile conveyor system at Shasta Dam; pneumatic tires beneath the belts as at Grand Coulee Dam; and double counterweighted "dipsy-doodles" as at the Permanente cement mill in California.

Another feature of the Anderson Ranch Dam belt-conveyor installation is the fact that the belts will generate some of the electricity needed for the dam's construction. In addition to providing electricity, generators on the belts also act as brakes to prevent too rapid speeds.

CONDUCTIVE HEELS

Remove Danger from Static Sparks

ALMOST perfect protection for such diversified workers as munitions makers and hospital attaches, a rubber heel which conducts electricity instead of insulating against it has been announced by The Goodyear Tire & Rubber Company. By means of a special rubber compound of which the heels are made, static electricity within a worker's body is carried off almost at the time of inception. Thus a sufficiently large accumulation of electricity to cause a dangerous spark is averted.

With normal rubber heels, the static electricity accumulates within a worker's body until it generates a spark strong enough to go through the heel and, at the same time, strong enough to be dangerous.

On hospital shoes, according to Goodyear, the conductive rubber heels perform an important function by protecting patients from dangerous sparks while undergoing operations in which electricity is involved They also guard patients against other vagrant sparks of static electricity from doctors and nurses.

Now being produced in large quantities, mainly for munitions makers, the conductive rubber heels are built with brass washers instead of conventional steel in order to provide better adhesion with the rubber. Each heel, before leaving the factory, is carefully tested with a low-voltage electric current passing between an electrode and a steel table on which the inspections are conducted.

CHEAPER ALCOHOL

Process Also Yields Inexpensive Protein

CONCENTRATED protein that can be sold for a little as five cents a pound will soon be available in large quantities as a by-product of alcohol distillation, according to present indications.

The protein—which is almost identical in appearance, consistency, and food value to dehydrated egg white—results from a new process for distilling alcohol discovered recently by government scientists after months of research at the Park and Tilford Distillery.

The discovery, which will have the immediate effect of considerable saving to the government in war-alcohol costs, was made by Irvin W. Tucker, a young chemist in the United States Department of Agriculture working under the direction of Dr. A. K. Balls, chief of the department's enzyme research laboratory. The new alcohol process is unusually rich in both wartime and post-war possibilities, according to Frank G. Handren, president of Park and Tilford Distillers, Inc.

Here are a few of the developments envisaged:

1. Recovery of one billion pounds annually of protein in a practically pure form, which can be used as a supplement to livestock feed, for protein enrichment of white flour for bread and cereals, and for processing into a number of essential chemical products, including casein—which now costs about 20 cents a pound.

2. Complete elimination of barley malt, now the most expensive single ingredient, from the alcohol distillation process.

3. Revolutionizing of the alcohol industry by making alcohol, now the principal product, assume the role of a by-product in the industry.

4. Large-scale production of grain alcohol after the war for synthetic rubber and other industrial products. Hitherto grain alcohol production costs have precluded such a development. The new process, when fully developed commercially, will cut grain alcohol producing costs in half.

At present, malted barley is employed in grain alcohol production because of its high concentration of diastase, an enzyme whose function is to convert the starch of cereal grains into sugar to serve as a digestible nutrient for the growing plant. In the distillation process, the barley malt converts the starch content to sugar, feeding distillers' yeast and giving off carbon dioxide and alcohol as by-products. Natural diastase is present in wheat and other grains, of course, but it is usually destroyed in the cooking process preceding the conversion step in distillation.

Under the Balls-Tucker process, a solution of sodium sulfite—a plentiful waste product of several industries, including pulp and paper, ore roasting

and coke making—is used to extract the diastase from wheat before it is cooked. The resulting solution supplants the barley malt hitherto used to convert the starch to sugar after cooking. Simultaneously, the sodium sulphite extracts the protein content of the wheat, which rises to the surface as a thick, yellow froth.

Little, if any, additional equipment at distilleries is needed to separate the diastase-containing froth from the virtually pure residue of starch. Drying out the froth is a simpler task than the ordinary distillery recovery process or than the more elaborate methods required to recover the spent residue of wheat. It is wheat, instead of the customary corn, that distillers are now using for war-alcohol production.

After distilling the alcohol, distillers ordinarily have the residual slop evaporated and dried. The resulting solids are sold to livestock feeders as "distillers' dried grains" for about two cents a pound. The Balls-Tucker process not only extracts the protein—the important constituent of dried grains—but it does so at the beginning rather than at the end of the alcohol production line. This reduces the bulk to be handled in the various stages of production and cuts down the residue to a thin slop which can be disposed of with relative ease.

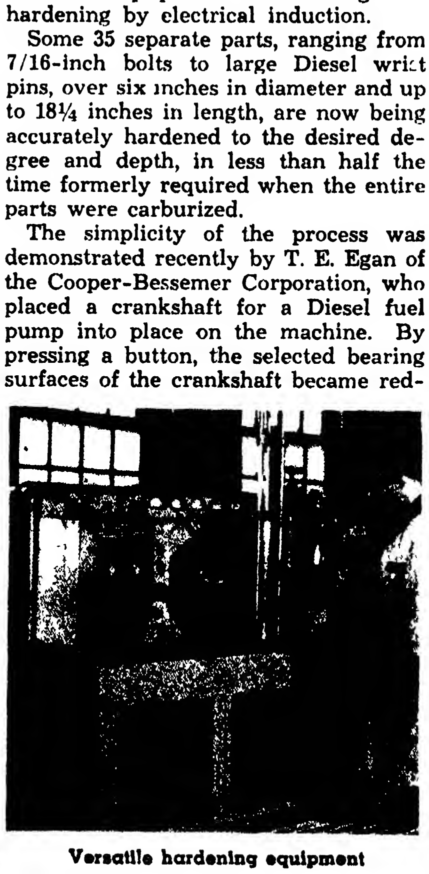
PARTS HARDENING

Speeded, Made Versatile, by New Electrical Equipment

At least 50 percent of the time formerly required to harden a wide variety of Diesel engine parts is now being saved by one company with recently installed equipment for heating and hardening by electrical induction.

Some 35 separate parts, ranging from 7/16-inch bolts to large Diesel wrist pins, over six inches in diameter and up to 18¼ inches in length, are now being accurately hardened to the desired degree and depth, in less than half the time formerly required when the entire parts were carburized.

The simplicity of the process was demonstrated recently by T. E. Egan of the Cooper-Bessemer Corporation, who placed a crankshaft for a Diesel fuel pump into place on the machine. By pressing a button, the selected bearing surfaces of the crankshaft became red-



Versatile hardening equipment

hot within a few seconds, and jets of water automatically sprayed the heated areas, thus quenching and completing the hardening operation.

By merely changing the fixtures and induction coils, many of which are designed and built in the Cooper-Bessemer plant, the machine is prepared to accommodate any one of the 35 items that are hardened in this way, and which include such parts as gears, cams, wrist pins, and ball races.

In hardening wrist pins, for example, an automatic, hydraulically operated fixture is installed which feeds the pin through the induction coils at a controlled speed so that the entire length of the wrist pin is heated to the desired temperature and quenched in one continuous operation.

"Hardening time for a wrist pin," said Egan, "is now reduced to 38 seconds. This process not only completes the work in seconds instead of hours, but also reduces distortion to a minimum and saves critical material by permitting us to use a carbon steel in place of high alloy steel formerly used"

ACOUSTIC STETHOSCOPE

Detects Sounds Within the Body Heretofore Unheard

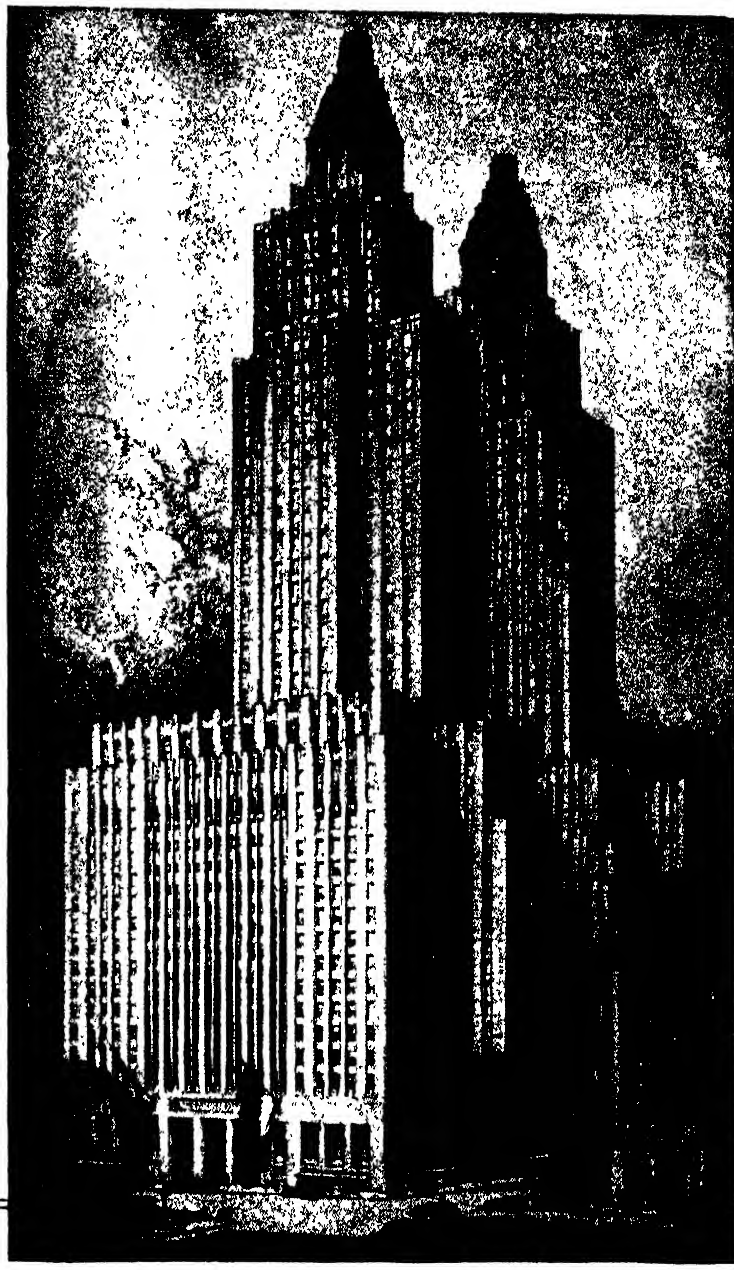
A NEW acoustic stethoscope, so sensitive in its range of hearing that it introduces many sounds doctors have never heard, promises to widen the study of sound within the human body. The beat of the heart, normal or abnormal, res-

Sounds never heard before

piratory rattles, peristaltic squeaks, murmurs, and groans, all are amplified to facilitate diagnosis, based upon the structure of sound.

It has been found the sounds of the body range from 40 to 4000 cycles, the full range of which is covered for the first time by the new stethoscope. Above 4000 cycles most of the sounds in the body are so weak that they are masked by the ambient random noises generated within the body. It is explained that respiratory sounds such as wheezes and the rushing of air are of a complex nature. Therefore, in designing the new stethoscope to gain maximum intelligence, the instrument transmits all frequencies over the range from 40 to 4000 cycles without attenuation or discrimination. The ordinary stethoscope has an effective range between 200 and 1500 cycles.

The advantages of the new stethoscope, according to Dr. Harry F. Olson,



come from the fact that it couples the ears of the diagnostician much more closely to the human body through the employment of a reversed taper tube which results in greatly improved matching of the acoustic elements. Thus, sounds produced by the organs of the body are heard more clearly and their range is greatly widened.

In fact, so many new sounds are heard with the instrument, developed by RCA Laboratories, that a filter is built into it to enable the user, by simply turning a knob, to limit the range at will. This was done at the suggestion of one of the testing physicians in order to prevent confusion until the meaning of the new sounds can be determined through further study.

HUMIDITY INDICATOR
Supplements Work of Silica Gel

An "automatic weatherman" that signals shippers and stevedores when the humidity inside munition crates rises to the rusting point is the packaging expert's newest means of protecting

Color tells the story

guns and engines from corroding during the weeks and months they lie in freighter holds and humid dockyards.

Enclosed with a silica gel rust protectant developed by The Permutit Company is a weatherman of cobalt-impregnated gel functioning like the old-fashioned Dutch-boy-and-girl weather indicators which warned of rain by turning pink. When the humidity in a package rises above the critical point, the weatherman—visible to inspectors from the outside—turns pink, indicating leakage of the moisture-proof bag in which the metal part is packed.

GLASS RECTIFIERS
Now Being Used for Industrial Alcohol Production

A marked speed-up in the rate of distillation of the rectifying columns used by the beverage distilling industry to produce 190-proof ethyl alcohol required for explosives, synthetic rubber, and other war and essential civilian uses, has been made possible by the development by Owens-Corning Fiberglass Corporation of a new glass fiber packing material for the columns.

The glass fibers can replace both the tinned-copper bubble plates with which the industry equipped its columns before Pearl Harbor, and the burned-clay Raschig rings which the industry resorted to as a substitute when tinned copper became unavailable. It is believed that the material will also prove practical for use in distillation applications in the chemical, petroleum, and other industries.

A principal factor in determining the rate of distillation of an alcohol rectifying column is the amount of exposed surface area which is presented for the condensation of water and other liquids. The ability of the glass fibers to increase the rate of distillation is due to the great increase in exposed surface area presented by the fibers, as compared to the exposed surface area presented by either the bubble plates or the Raschig rings.

One method employed in packing the columns with glass fibers consists of placing them in large, expanded-metal baskets which fit, one over the other, into the inside of the column. When used at their normal density of 3.5 pounds to the cubic foot, the fibers present 135 square feet of exposed surface area per cubic foot. This compares with an exposed surface area of 56 square feet per cubic foot when the Raschig rings are used.

The operation of columns packed with glass fibers is identical with that of columns packed with Raschig rings, or fitted with bubble plates. Heated vapors from stills producing the normal run of 120-140 proof alcohol pass up through the column. Water and other liquids with a boiling point higher than the 170 degrees, Fahrenheit, boiling point of ethyl alcohol condense on the bubble plates, Raschig rings, or glass fibers, and flow back to be re-heated and revaporized by the rising vapors from the still, until the last vestige of alcohol is extracted from them.

The vapors which finally pass out through the top of the column into a condenser become 190-proof alcohol with only 5 percent of water content.

GLASS KITE STRING
Used to Carry Radio Antenna Aloft

A kite string of glass yarn is used with the box kite that carries aloft the antenna of the portable, hand-generator, radio transmitter developed by the Army Air Forces to summon help for fliers forced to make crash landings at sea.

The complete transmitter kit for use on aircraft life rafts includes the sending set, an ordinary cloth and wood-frame box kite, an antenna consisting of very fine copper wire wound around the glass kite string, two balloons, and capsules of compressed hydrogen. The ballons, inflated with the hydrogen, can be used to carry the antenna aloft in the event of a calm.

Glass yarn is used as the kite string because of its great strength in proportion to its weight, and because it will not rot or otherwise deteriorate from

the effects of salt water, tropic sunlight, rain or dampness. The yarn is twisted and plied from continuous filament glass fibers which can be drawn to indefinite lengths, measurable in miles.

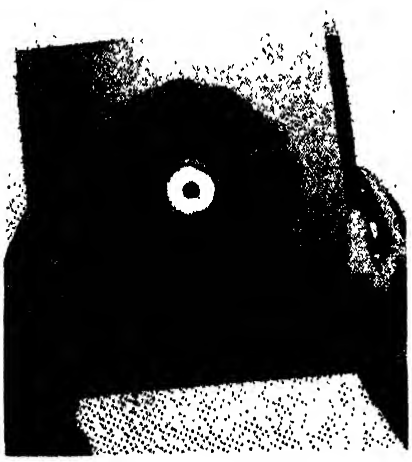
The transmitter is so constructed that the operator needs no knowledge of radio or code. When the hand crank is used to generate power the transmitter automatically grinds out the SOS signal on 500 kilocycles, the international distress frequency.

"FOOTPRINTS" IN LACQUER
Reveal Secrets of Strains in Metal

THE lacquer-held "footprints" of a bullet crashing into steel plate are giving experimental scientists new information which may aid in the development of tougher armor plate and better armor-piercing shells for the nation's fighting men. The "footprints" are thin, closely spaced cracks which appear on a lacquer-coated steel target under the impact of a bullet. Dr. Miklos Hetenyi is conducting the experiments in the Westinghouse Research Laboratories.

"Some shots fired in the laboratory," says Dr. Hetenyi, "create a heart-shaped pattern extending six or eight inches from the spot where the bullet hit or penetrated. In other tests the cracks form a series of circles around the bullet hole. Each tiny crack denotes stretching of the metal underneath the lacquer and gives us a permanent picture of the strains that occurred at the instant of impact."

By spraying this smooth lacquer coating, known as Stresscoat, on metal parts and then contorting them until the brittle skin cracks, research engineers can also detect vulnerable spots in



A bullet's "footprint"

gears, shafts, valves, and other parts of vital wartime equipment.

"This lacquer coating test," Dr. Hetenyi says, "is accelerating improvements in motors, gears, and various types of electrical machines because it enables us to locate strains quickly. Of course, 'life' tests are still necessary but the cracked coating process tells us when we are on the right track in designing new parts."

Just as yawning crevices opened by an earthquake reveal faults deep un-

Spraying a gear tooth for test

derground, tiny fissures in the lacquer tell a story of the strains that machine parts experience. Cracks in the glossy finish pick out the "Achilles heel" of an eight-foot-high two-ton gearwheel or bare the weak points of a flapper valve, a tenth-of-an-ounce slice of steel that vibrates back and forth in air cooling machinery.

In one test the lacquer coating was put on a 1600-pound "model" of a gear tooth; the tooth was then squeezed in a large hydraulic press to locate the stresses accurately. Results of this work were turned over to the Nuttall Gearing Works of Westinghouse which is manufacturing gears for submarines, subchasers, and other war equipment.

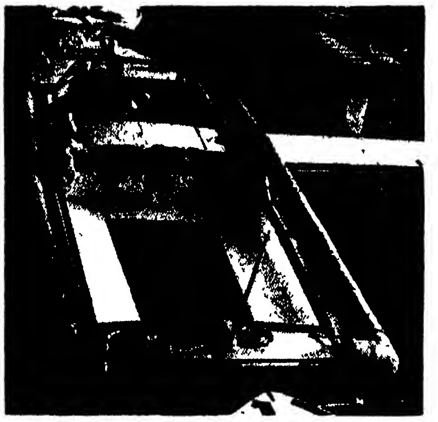
Lacquer sprayed on the gear tooth dries in 15 hours to form a tightly clinging skin about as thick as the diameter of a human hair. To determine the slightest strain that will crack this coating, a foot-long steel bar is sprayed at the same time as the gear tooth and under the same atmospheric conditions.

The steel bar is bent in a machine that holds it rigid at one end and depresses it at the other. Most of the cracks in the coating appear at the rigidly-held end and become less frequent until there are none at the end which was pushed down. Then the bar is placed beside a strain scale which is read opposite the point where the last crack occurred.

BOAT BUMPERS
Being Made From Rubber Cushions

PEACETIME'S bus, railroad, and automobile cushions and similar products made of foamed rubber are going to war in a new guise· They're helping to protect seaplanes and flying boats from damage in rough water at bases and harbors all over the world. To this end a supply of Airfoam products no longer useful for their original purposes is being converted into protective paddings for the gunwales of United States Navy personnel boats which service seaplanes.

The production of civilian products with Goodyear Airfoam ended with Pearl Harbor, and the present supply of



Rubber boat bumpers

cushions and similar materials being converted to gunwale pads was accumulated before Pearl Harbor. The cushions are cut apart to fit inside tubes of wear-resisting and weather-proof fabric. The tubes are made in such a manner that each short length contains a "V" which fits over boat gunwales. Then the tubes are lashed together into strips which extend for the entire length of a gunwale and the strips are lashed to the boat. Thus the strips are quickly interchangeable from one boat to another as it is placed into or removed from seaplane servicing.

OIL LINE MIXING

Can be Economically Determined in Advance

MORE fuel oil and gasoline will be available for the furnace and automobile next winter as a result of an investigation recently completed by Prof. Geo. Granger Brown of the University of Michigan and Frank C. Fowler of Phillips Petroleum Company (formerly with the University of Michigan) and announced to the American Institute of Chemical Engineers.

In the "big inch" and "little big inch" pipe lines from the Texas oil fields to the Eastern States, a few thousand barrels of fuel oil may be followed by a quantity of aviation gasoline, and that in turn by some other product of the refinery. Naturally, there will be some contamination where two products meet. In order to avoid the loss of considerable volumes of these materials it is essential that the operators of the pipe lines know how much of the oil and gasoline are mixed. This can now be determined in advance. The first public account of the fundamental factors controlling the intermixing or contamination of the various products transported in a pipe line by successive flow was given by Professor Brown and Mr. Fowler. They reported the relationship of the various factors—viscosity of the fluid, diameter of the pipe, velocity of the flow, and length of the pipe line—and their effect on successive products.

Due to the increased efficiency of transporting refined products rather than the crude oil itself, the petroleum industry had previously adopted a practice of refining the crude oil into finished products on the Gulf Coast of Texas and transporting the products by tankers to the East Coast. This procedure is more efficient not only because of the slightly lower fuel cost in Texas, but also because it is not then necessary to transport the "refining losses" but only the actual products which are desired.

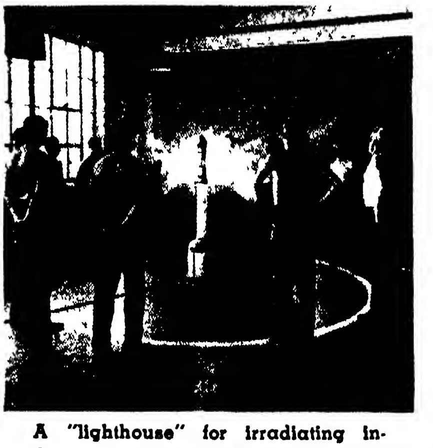
In order to utilize the refinery capacity of the country on the most efficient basis, it is therefore necessary to provide adequate transportation of finished products from Texas to the East Coast. This is to be accomplished by transporting fuel oil in addition to crude oil through "big inch," 24-inch crude-oil pipe line, from Longview, Texas, to Norris City, Illinois, and by providing the "little big inch," 20-inch products pipe line, to transport gasoline from the Gulf Coast to the same eastern area. These product pipe lines are a recent development in the petroleum industry and have been used with considerable economies and great success in transporting finished products from the south to the north and east.

ULTRA-VIOLET "LIGHTHOUSE"

Developed to Irradiate Industrial Workers

A NEW type of low-cost miniature "lighthouse" that broadcasts ultra-violet health rays to keep war workers well has been developed by the Hanovia Chemical and Manufacturing Company, and has been installed in a plant of the RCA Victor Division on recommendation of the plant's War Production Drive Committee, in co-operation with the medical staff.

"Standing in a circle five feet from the lighthouse, 15 men or women can simultaneously receive ultra-violet applications within a few minutes, enabling the handling of hundreds of plant workers daily," Frederic W. Robinson,



A "lighthouse" for irradiating industrial workers with ultra-violet

Hanovia's director of research, explains. "Five-minute daily applications are sufficient.

"A novel feature of the new design is that the use of aluminum reflectors is avoided, thus saving critical materials, and, at the same time, the radiation output of the lamp is more fully realized than ever before. Furthermore, laboratory developments on the high-pressure quartz mercury lamp used have resulted in reduced operation costs, making irradiation of large numbers of war workers practical."

Previews of the Industrial Horizon

(*Continued from page 99*)

sections, light weight, good aging qualities, resistance to chemical attack, and moldability with existing equipment with minor modifications. No nylon plastic may be had for the duration, other than for vital military applications, but here is one more development that will leap forward when the bars are lowered.

HIGH-SPEED PHOTOGRAPHY

DEVELOPED for studying the detonation waves of explosives, the new rotating drum camera, described on page 124, is one of those useful scientific tools that will undoubtedly find many uses in industry other than the one for which it was initially designed. Where action—mechanical or otherwise—takes place at high speeds, much can be learned about stresses and so on if it is possible to photograph the action while it is taking place. This can be done with the camera described, adding new chapters to many research stories.

BETTER DYES

DYES DEVELOPMENT, reported on page 121, is part and parcel of the intriguing saga of the growth of the chemical industry in the United States From work on dyes has come basic knowledge that has branched out into other fields of chemistry; dyes experts are playing a large part in present war-time research; they will be equally important in the field of consumer and heavy-industry synthetics after the war.

SEWAGE TREATMENT

INDUSTRIAL water supplies and power sources are being found in sewage by engineers concentrating on the important problem of sewage treatment Here is research closely linked with community development that, while it disposes of wastes in a modern and sanitary manner, also provides dollar value in the form of things that industry needs. The post-war world will benefit in more ways than one. For details see page 106.

WHAT SHALL WE EAT?

HOW FAR the food-dehydration industry will affect the eating habits of the people of the United States after the war will probably be largely determined by those men who are now in the armed forces where they are being fed large quantities of dried foods. If they relish these foods and demand them upon return to civilian life, the industry will flourish and prosper; if not, the industry will fall back to those staple forms of pre-war days and will shrink correspondingly

While dehydration of food serves a very useful purpose where shipping facilities are limited, it will never be an important factor in the food field when these restrictions are removed unless the food is equal in every respect to that obtainable through other means.

HOW HARD IS HARD?

IT MAY come as somewhat of a surprise to those who have never given the matter much thought to find, in the article starting on page 109, that science really does not know very much about the hardness of materials. Many industrial operations are predicated on this factor yet, in the final analysis, knowledge is applied empirically. When restless research finally finds all the answers to the puzzle of hardness, industrial technology will make a long step forward in its methods of handling many materials.

RADIO STANDS READY

THE LARGE part which radio is playing in the war on all fronts foreshadows many of the applications that will become common-place in days of peace. Practical use of developments directly attributable to military requirements will be made not only in the fields of communication but also in that of transportation, among others Thus we may someday see airplanes, ships, and all manner of ground vehicles being guided through all weather conditions by radio equipment; radio channels will serve as "tracks" which they will follow with absolute safety.

BETTER AUTOMOBILES

DUST, one of the banes of military operations, is a deadly enemy of automotive vehicles, yet up to the beginning of the war it was considered sufficient to provide a carburetor air cleaner and let the dust problem go at that. Now, however, it is found that combat vehicles need far more protection than ever before thought necessary. As a consequence, dust-proofing is being extended to clutches, transmissions, instruments, brakes, and even to fan belts. Out of this work will come dust-proofing of many parts of the post-war "pleasure" car, with resulting longer life of parts, more efficient operation, and fewer troubles.

WEAR-RESISTANT

A COMPETITOR of other and more conventional materials in luggage and packing case construction is seen in a new material that uses blotting paper —no less!—as a base. This paper, as told on page 138, is saturated with a synthetic rubber and processed to become tough and wear-resistant Thus a new and low-cost product looms on the horizon to give added impetus—and variety—to a number of post-war consumer industries.

New Products

CLASSIFYING DEVICE

RECENTLY developed to classify and sort .30- and .50-caliber armor-piercing bullet cores and 20mm shells automatically, a new Toledo Dynamic Classifying Device has many similar applications in other industries. Pieces to be weighed, or classified, must be of such a character that normal variations in weight do not materially effect the position of their center of gravity. Spheres, cylinders, rectangles, and similar regularly formed parts conform to this requirement. Weights from ¼ ounce up to 6 ounces can be handled.


Sorting by weighing

As the parts are fed into the device, they are automatically deposited on the end of a lever. The loaded end of the lever is released, permitting that end to fall (dynamic weighing principle). Parts are weighed in motion, and the interception of a light ray by the weight beam causes a photo-electric cell to operate the mechanism for automatically discharging the parts into one of three chutes, which classifies them as "Under-Weight," "Within-Tolerance," or "Over-Weight."

RESILIENT FLOORS

RECENTLY improved is an asphalt-asbestos floor tile designed for industrial use. The tile surface is resilient and wear resistant, is claimed to be non-slip when wet. The surface is non-sparking and will melt before it will burn. This tile, made by David E. Kennedy, Inc., is finished in three different sizes and seven colors.

WATERPROOF TAPE

FOR sealing water-resistant cartons carrying vital overseas-bound cargoes of ammunition, medical equipment, food, clothing, instruments, and thousands of other necessities, there has been developed a waterproof tape, known as Solseal, which is applied in the same simple manner as regular sealing tape, using the same type of moistening dispenser. A special Solseal solvent, used as a moistening agent, is a non-inflammable, non-volatile, non-corrosive mixture of chemicals that will, upon wetting Solseal, cause it to become waterproof after a 72-hour period. Bondings effected with Solseal Tape, immersed in water under strain, have withstood that immersion for weeks, in some cases over eight weeks, without any releasing of the tape, it is claimed.

CORROSION PREVENTION

PROTECTION of finished machinery and other materials which might corrode during transportation may be provided by bags of silica gel, which are placed in the containers with the material to be protected. The bag containing the gel, manufactured by Culligan Zeolite Company, is made of cloth with a breathing-type paper lining. The gel absorbs all moisture within sealed containers, thus preventing corrosion

DECALCOMANIA NAMEPLATES

TOUGH and resistant to scratching and wear is a new transfer nameplate made of non-critical materials. It is claimed by the Myercord Company, manufacturers of these nameplates, that they have effectively withstood weathering and salt-spray tests. These included exposure to temperatures of 200 degrees, Fahrenheit, and 98 percent humidity, followed by temperature drop to minus 40 degress, Fahrenheit. The transfers are available for use on polished and wrinkle-finish metal surfaces, designs and colors being to specifications.

METAL WASHING

TO MEET the need for high-speed washing of flat, fragile work or circular parts with intricate pockets and crevices, the Tabl-Spray washing machine has been developed by American Foundry Equipment Company. By complete exposure given the parts in rotating them through the path of well-positioned power sprays, this new unit insures uniform coverage and thorough speed cleaning.

Parts to be cleaned in the Tabl-Spray are placed on the mesh table and


For high-speed parts washing

rotated through the spray solution, discharged from special machined non-clogging nozzles.

After the few minutes required washing time, the solution valve is closed and the parts are left rotating to obtain proper drainage. If rinsing with fresh water is desirable, this operation can be handled without transferring parts to another compartment, by means of a special arrangement of drainplates. A compressed air blowoff can follow the cleaning to remove excess liquid from the parts.

Typical cleaning applications include removing lapping compound, oil, and chips from magnesium and aluminum aircraft parts, cleaning crankcases, supercharger rear housings and adapters, small assemblies, gears, or rocker arms prior to inspection or after magnaflux.

NON-SPARKING CONTAINER

Conductive synthetic rubber, made by the United States Rubber Company, is now being fabricated into carrying boxes, buckets, and trays for handling explosive materials. Containers made of this material can not strike sparks; because of the conductive qualities of the rubber, static charges cannot accumulate to a point where disastrous sparks might be discharged

SAMPLE DRYER

Using a principle different from that usually employed in drying sample swatches of cloth, the Rodney Hunt Machine Company has developed a

Textile dryer and conditioner

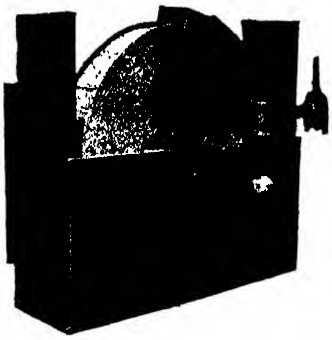
unit to perform this operation at what they state are phenomenally high speeds.

The conventional way to dry samples in a textile mill is over a steam pipe or by a hair dryer. The dyer cuts a sample four-inch square, dries it for 10 or 20 minutes, and then waves it around in the air to condition it to room temperature and humidity before matching. Not only does this take valuable production time but it also gives the cloth in the dye kettle a chance to change shade, lessening the accuracy of the match.

The new unit, known as the "Whirlwind" Sample Dryer, does both the drying and conditioning operations in from one to two minutes, depending upon the material. The process is basically one of rotating the samples at high speeds, first in a dryer cabinet and then in the room at normal temperature and humidity. The samples are placed on wire screens on a disk or rotor which is attached to the inside of the door of an insulated cabinet. The door is closed, the motor turned on, and the samples rotate inside the cabinet at great speed. After the sample is dried, the door of the cabinet is opened and the sample continues to rotate at room temperature and humidity until conditioned properly.

SPIRAL PUMP

When it is necessary to handle liquids containing solids such as sand, abrasives, crushed ore, and so on, a new rotary spiral pump can be pressed into service to handle up to as high as 91.6 gallons per minute. These pumps, in wooden



The spiral does the trick

housings as illustrated, pick up the liquid and solids at the open end of a spiral, setting up a flow through the spiral to an outlet at the center. Rotation speed is 20 revolutions per minute. These pumps, known as the Frenier sand pumps, are available in three diameters with lift capacities from 12 to 22 feet.

THICKNESS GAGE

The thickness of steel plate can be measured with a new electrical instrument even though access is available to only one side of the plate. This new gage, a product of the Metron Instrument Company, will operate on maximum plate thicknesses up to ⅝ of an inch.

This instrument contains two iron-core magnets connected in a balanced bridge circuit. One of the magnets is designed to be placed against the plate to be measured while the other is mounted on the instrument housing and has an adjustable armature to

provide for calibration. Through a balancing of the bridge circuit it is possible to determine the influence of the steel plate to be measured upon a magnetic field. Since this influence is related to the thickness of the sheet, thickness readings can be taken direct from the meter once the instrument has been calibrated.

RIVET BUCKER

AUTOMATIC bucking and riveting by one operator is made possible with the tool shown in these columns. In it a standard rivet set is synchronized with an air

Treadle controlled

cushioned bucker, the two parts always being perfectly aligned to insure accuracy in riveting. The treadle control enables the operator to use both hands for guiding the work. When the rivet set hits the rivet, the bucking bar is always in contact wih the shank.

BRAZING FLUX

WHEN a new granular fluxing material, developed by Chicago Welding Sales Company, is used for brazing of cast iron parts, initial cleaning or grinding of the break to be welded is stated to be completely eliminated.

RUBBER PAPER AND GASKETS

BLOTTING paper may soon go traveling and see the outside of the world's buildings instead of hiding away 'in desk drawers The Hycar Chemical Company of Akron has found a spectacular assignment for blotting paper. With this company's butadiene synthetic rubber as a saturator and binder, blotting paper may go into luggage—hand bags, suitcases, fitted cases, even packing cases.

According to tests made in the company's laboratories, highly absorbent blotting paper immersed in the hycar latex, and then dried in an oven, becomes a tough, wear-resistant material that is ideally suited to the manufacturing of luggage items. The treated paper is not affected by oil or other solvents and can be prepared in any of the standard colors.

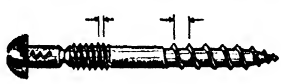
Another use for synthetic rubber, recently announced, is a gasket material consisting of copper mesh coated with synthetic rubber, originated by The Detroit Gasket and Manufacturing Company and produced by The Goodyear Tire and Rubber Company. This rubber-sheathed mesh has survived exhaustive tests and now is standard equipment for many airplane engines produced in this country.

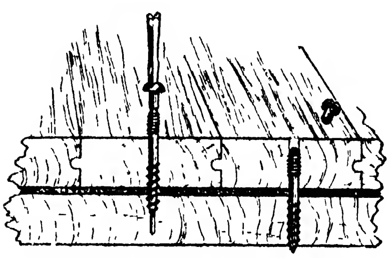
The rubber-sheathed gasket, less than 15 one-thousandths of an inch in thickness, is made of 80-mesh copper screening which has a tensile strength far in excess of any internal pressure which may be encountered. Thus the wire, as a reinforcing medium, provides insurance against leaks due to blowouts, the synthetic rubber coating providing the necessary binding medium for the wire mesh as well as the resiliency required to obtain perfect alignment in the assembly.

LOCKING WOOD SCREW

A WOOD screw that prevents the slipping of any two boards, by locking them permanently, has two threads of different pitches With each turn of the screw, the boards are pulled together by an amount equal to the difference between the pitches of these threads. This difference in pitch results in obtaining a greater "pulling together" action than can be secured by an ordinary wood screw, plus the equally important feature that, when properly installed, the Wil-Son No-Slip screw leaves only a small hole, in fact not much larger that a nail hole, which can easily be sealed with Plastic Wood or other compound.

When installing the screw, a small hole is drilled to a depth equal to about three-quarters of the length of the screw. The No-Slip screw is then screwed into this hole. The coarse threads first pass through one board and then into the others. The slightly larger fine threads then begin to engage the first board, and, as the screw goes





How the locking wood screw works

down farther, the difference in pitch between the two threads causes the two boards to be pulled together gradually until finally both boards become tightly joined.

The operator then may break off, with a pair of pliers, the top of the screw at the groove which is just above the fine threads. An unusually hard twist on the screw driver will give the same result. When properly installed the breaking off point is always below the surface of the wood.

Current Bulletin Briefs

Conducted by

K. M. CANAVAN

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

CRISIS IN RUBBER is an illustrated pamphlet which describes wild rubber, plantation rubber, domestic rubber, synthetic rubber, and integrates the whole into a story which gives a reasonably complete grasp of the rubber situation as it stands today. *The B. F. Goodrich Company, Akron, Ohio.—Gratis.*

SAVE WITH "BALANCED" LIGHTING is a 10-page pamphlet which tells in text, drawings, and photographs how best to apply local and general lighting so that a balanced, efficient, and economical condition results. *The Fostoria Pressed Steel Corporation, Fostoria, Ohio.—Gratis.*

UNIVERSAL ANGLE DRIVE is an eight-page illustrated folder describing a bevel-gear drive for manual operation of valves and other devices on shipboard and in industry. *Payne Dean and Company, Dean Street, Laconia, New Hampshire.—Gratis.*

ALGOMA TEMPLATE DIES is a four-page bulletin describing a new process of manufacturing blank and pierce template dies at a fraction of the cost of conventional dies. *Algoma Products, Detroit 12, Michigan.—Gratis.*

HANDBOOK OF EMERGENCY WAR AGENCIES is a 144-page publication which outlines briefly the function and organization of Federal War Agencies as well as Army and Navy Departments and the Maritime Commission. Names, addresses, and telephone numbers of principal officials are listed. *Superintendent of Documents, Government Printing Office, Washington, D. C.—20 cents.*

VERY PROMPTLY YOURS, by Robert E. Ramsay, is a 16-page booklet pertaining directly to office correspondence. It gives suggestions for filing and cross-filing, for a simple letter-writing plan, and for speeding up correspondence. *Hammermill Paper Company, Hammermill Road, Erie, Pennsylvania.—Gratis.*

VEGETABLE DYES is a 56-page pocket-size book which tells specifically how to make dyes at home from barks, weeds, berries, and fruit. *Oxford University Press, University Avenue, Toronto 2, Ontario, Canada.—35 cents.*

MOGUL METALLIZING PROCESS AND EQUIPMENT is an illustrated pamphlet describing the metallizing process for building up worn metal surfaces, to render exposed surfaces corrosion resistant, and so on. Also presented are specific applications of the process, and a listing of the equipment necessary for metallizing. *Metallizing Company of America, 1330 West Congress Street, Chicago, Illinois—Gratis.*

SOME FUNDAMENTALS OF TIMBER DESIGN, by Howard J. Hansen, is a 76-page booklet which covers characteristics influencing design, methods of fastening wooden members together, types of beams and columns, and glued laminated construction. Numerous valuable tables and charts are presented. Bulletin No. 66. *Texas Engineering Experiment Station, College Station, Texas.*

REVIEW OF "PATENTS AND FREE ENTERPRISE" Monograph No 31, Temporary National Economic Committee, is a pithy comment on Walton Hamilton's monograph, as presented by Anthony William Deller, a patent attorney and member of the New York Bar. This review is a plea for the protection of inventors and their rights under the patent system. *Anthony William Deller, 67 Wall Street, New York 5, New York.*

CENTRIFUGAL CASTINGS is an eight-page folder which tells briefly how a centrifugal casing is made, lists the wide ranges of sizes available, and tabulates the chemical and physical properties of a number of standard alloys which are cast by the centrifugal process *Shenango-Penn Mold Company, Dover, Ohio.—Gratis.*

CELESTIAL NAVIGATION FOR AVIATORS, by Clarence H. True, is a 32-page illustrated booklet offering a method by which spherical triangles are solved without spherical trigonometry.—*Clarence H. True, Civil Engineer, Box 318, Balboa Heights, Canal Zone—$1 50 postpaid.*

CURLED CHIP METAL CUTTING SYSTEM is a lavishly illustrated plastic bound catalog which presents what is termed "an amazing and revolutionary advancement in metal cutting history.' Descriptions and photographs are presented of saws designed in accordance with this new system. *E. C. Atkins and Company, Indianapolis, Indiana—Gratis.*

CARBONIA is a four-page folder describing a process for obtaining a gun-metal finish on ferrous metal parts. This finish is applicable to many articles in bulk and is applied at the same time that the work is tempered. *American Gas Furnace Company, Elizabeth, New Jersey—Gratis if requested on business letterhead*

HOW TO BRAZE WITH PHOS-COPPER is a 12-page booklet describing the use of a brazing alloy which can be used with gas, incandescent carbon, electric furnace, and dip brazing methods. Request Booklet B-3201. *Westinghouse Electric and Manufacturing Company, Department 7-N-20, East Pittsburgh, Pennsylvania.—Gratis.*

Telescoptics

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

YERKES was a Chicago traction magnate with plenty of wealth. The late Dr. George Ellery Hale tactfully made him realize that man is mortal and that after a few years the world would forget his name and his multi-millions, but by donating a big telescope to science, he could become an immortal. Hale got the money for the 40" telescope and Charles T. Yerkes got his immortality—which included burial in a crypt in the telescope's pedestal.

Amateurs who have made exceptionally good telescopes may, too, become immortals without the bother and annoyance of being rich, by dedicating these instruments to some educational institution or other corporate body (the burial beneath is not a requisite; in time it might even prove embarrassing). Cyril G. Wates, 7718 Jasper Ave., Edmonton, Alberta, whose 12½" Newtonian reflector (Figure 1) was briefly described in this department in December 1941, has now thoughtfully dedicated it to the University of Alberta, at Edmonton, Alberta, Canada.

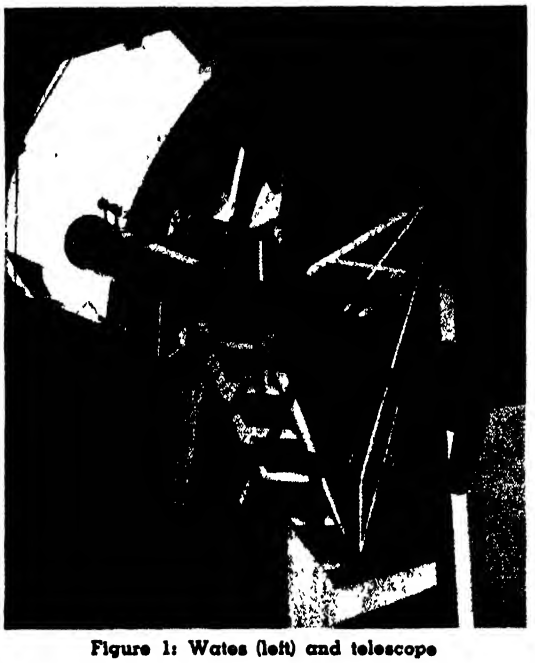


Figure 1: Wates (left) and telescope

Figure 2 shows the group present at the ceremony. Wates stands between Hon. J. C. Bowen, Lt.-Governor of Alberta (with cane) and (toward the reader's right) Dr. R. Newton, President of the University. There were ceremonies, Dr. J. Pierce, Director of the Dominion Astrophysical Observatory at Victoria, B.C., gave the address, and Wates, not brawny enough to hand the president the telescope, handed him the eyepiece instead. Such a party is a Big Day for the donating immortal.

Asked to describe the telescope and dome, Wates writes:

"The 12½" mirror is Pyrex, ground and polished by hand, but figured on a Hindle machine. Focal length 110". The tube is cedar, glued up from 20 strips and then turned. It is strengthened with cast-iron rings. Just above the mirror cell is a lead counterweight, made in four segments and encircling the tube. The head of the tube, carrying the finder, eyepiece adapter, and 2" Bausch and Lomb prism, rotates on ball bearings, and is turned by a handwheel and pinion working in a circular rack, which was filed out with the aid of a hardened steel template.

"The finder is a 4" RFT with aluminum tube. There are no cross-hairs, as the telescope is to be used for clusters and so on as well as for a finder.

"The main tube is mounted in a frame of 2½" angles, in a similar manner to the 100" at Mount Wilson, but the declination bearings are offset a foot from the polar axis, to provide greater accessibility to the circumpolar stars. There is a 150-pound counterweight to balance the tube.

"The lower end of the polar axis rests in a conical roller bearing, and the upper end turns in a heavy ball bearing. Provision is made for adjustment of both axes, by means of push screws. The drive, not yet installed, will be a modification of the Boyd Brydon drive, with a slip clutch.

"The declination scale is a strip of Celluloid, engraved with a tool made from a Schick razor blade and stamped with steel letters from an old Addressograph. This scale is bent around a semicircular block attached to the polar axis frame, and is viewed by means of a simple periscope from a point close to the main eyepiece. The hour angle scale is an iron hoop 3' in diameter, enamelled white and carrying black markings.

"The main dome is an exact copy of the dome of the observatory at the Rensselaer Polytechnic Institute, Troy, N. Y., and was built from blueprints furnished by Dr. Carragan of that institution. The ribs are cedar, with a covering of Masonite, painted aluminum. The slit is fitted with a curved shutter, conforming to the dome and moved by endless chains running on sprockets, operated by means of a worm gear hoist.

"South of the dome is an extension with a roll-off roof, housing a 4" refractor, a transit, and a zenith telescope. These instruments and the reflector are mounted on heavy concrete piers running below frost line—which is about six feet in these parts! The mounting for the refractor was built locally from my designs, and works very smoothly."

Because of cramping and bad lighting it is notoriously difficult to take a good photograph of a telescope within a dome. This hazard was obviated by using a combination of daylight and flashlight—a point possibly worth remembering.

ONE way to lay out a setting circle is to make full use of the work already done by others in laying out gears. Figures 3 and 4 show how one amateur, a Wyoming physician who prefers anonymity, did the job, and are almost self-explanatory when studied.

In Figure 3 the blank is being faced in a lathe. In Figure 4 is the special set-up devised by the doctor, consisting of an 80-tooth wheel bolted to the headstock spindle, a supporting piece screwed to the bench, a 72-tooth wheel, and a ratchet engaging the latter. Figue 3 reveals the missing small gear, having 16 teeth.

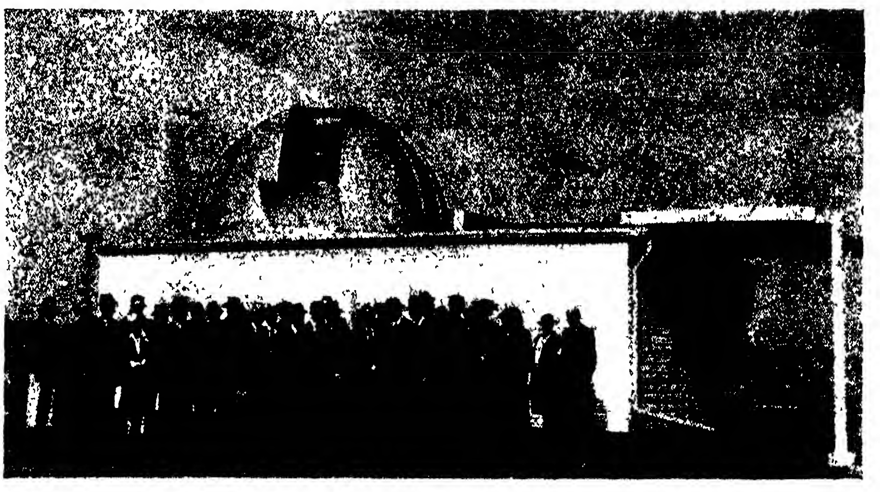


Figure 2: Wates with celebrities at the dedication ceremony

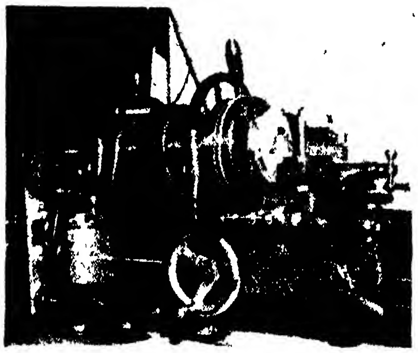


Figure 3: Facing setting circle

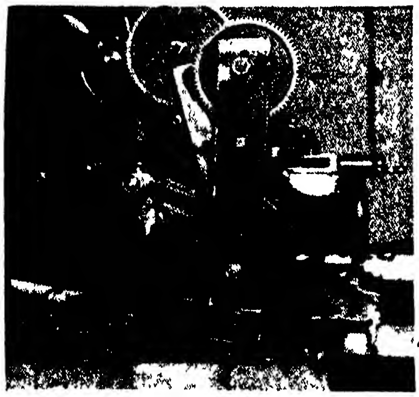


Figure 4: The spacing set-up

The ratchet, working on the 72-tooth wheel, would alone give divisions of 5°. To reduce these to single degrees a 16-tooth wheel on the same spindle meshes with the teeth of the 80-tooth wheel, giving a reduction of 5 to 1

The ratchet has a rubber band spring. The maker states that, using a carbide tool ground to a long taper and whetted on an oil stone, he was able to make the degree marks on a 4" blank in about 40 minutes.

Lesser details and the maker's name and address are available to especially interested readers.

JOHN R. HAVILAND, 426 Second Ave., Lyndhurst, N. J, author of the famous book-length chapter on the objective lens, in "Amateur Telescope Making—Advanced," sends us the following on the Barlow lens:

"So many inquiries have been made regarding Barlow lens behavior that the following is submitted to relieve my 'homework' on the subject.

"In July, 1937, the method of designing a Barlow lens was described [also by Haviland.—*Ed.*] in this column but no exposition of what happened in a telescope system was included. So here goes:

"In 'A.T.M.A.', page 231, there appears the formula for separated lenses, viz., $F = (f_1 \times f_2) / (f_1 + f_2 - d)$, where F = focus of combination, f_1 = focus of telescope objective, f_2 = focus of Barlow lens, and d = distance between the two lenses.

"Suppose we had a Barlow of focal length $-18''$ (minus because the lens is diverging or negative) used with a 6" reflector of 48" focus. Suppose further that the Barlow is placed 2" inside the focus of the mirror. What is the new focal length? What is the magnifying power? We get out our pencil.

"Substituting in the formula:

$$F = (48 \times -18)/(48 - 18 - 46) = -864/-16 = +54.$$

"Note that the eyepiece has to move 6" out to the new focus. As the Barlow moves in toward the mirror the eyepiece moves out and the magnification increases.

"The magnifying power of this combination may be found by dividing the length of the cone cut off by the Barlow into the length of the new cone formed (Hindle, in 'A.T.M.', page 215). Referring to Figure 5 it will be noted that the cone cut off is 2" long and that the new cone is 8" long. The quotient of these is 4. Thus the magnifying power is equivalent to that of a telescope having four times the focal length of the original.

"A magnifying power of four is about the maximum desirable. Make the Barlow lens of sufficient diameter to include slightly more than the diameter of the cone of light from your objective when the Barlow is placed as far within the focus as it will be used. ¾" would be about right for the example above, since a ½° diameter field is about this size 2" inside of focus in a 48" focus telescope.

"As in any system which magnifies, the intensity of illumination goes down. In the above example the image of the Moon would be about 2" diameter. No ordinary eyepiece would accept an image this size. The illumination when using a 1" (equivalent focal length)

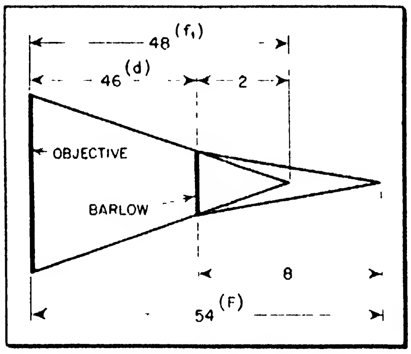


Figure 5: Barlow lens layout

eyepiece with the Barlow will be the same or better than when using a ¼" eyepiece without it—the magnification being the same in each case.

"The advantage of the Barlow is that the cone of light from it has a more acute angle at the vertex than the cone from an $f/8$ reflector. Thus, cheap eyepieces (Huygens or Ramsden) will perform satisfactorily with it and will be comparatively free from the bad color and spherical aberrations which they produce when fed the wide angle beam from a large aperture-ratio objective. Despite the imperfect achromatism of the Barlow, the overall result will be an improvement over the common reflector and Huygens eyepieces. Most of us can't afford the trick eyepieces needed to give good color correction on reflectors, so the Barlow is an easy way out of this difficulty, as well as furnishing an exercise in making an achromatic lens of not too rigorous limits of figure and achromatism"

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with the names of available books, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for. Books listed in these columns may be ordered from our Book Department. Add 25 cents per book for mailing outside U. S.

Conducted by JOHN P. CANDIA

THE MACHINE TOOL PRIMER

By The Herbert D. Hall Foundation

A BRIEF but comprehensive and all-inclusive summary of the metal working industry, presented in language devoid of technicalities and obscurities. The text covers the principal tools used in metal working, mass production methods in industry, the organization of a metal working plant, methods of measuring and improving efficiency, and how to use the tools upon which metal working is based. The appeal of this generalized text is wide indeed—anyone, young or old, who may want or need a fundamental knowledge of machine tools and their applications will find that knowledge available here in a form that is easy to assimilate yet adequately complete within its scope. (280 pages, 7½ by 10½ inches, 341 excellent drawings and photographs.)—$1.60 postpaid.—*A.P.P.*

HEAT TREATMENT OF METALS

By J. Winning

CONDENSED yet fairly complete is this straightforward account of heat treating methods and the underlying principles on which they are founded. Although essentially concerned with British practice, the text will be of value to industrial engineers in this country who have need for a generalized survey. (100 pages, 5½ by 9 inches, 39 drawings and photographs.)—$1.60 postpaid.—*J.P.C.*

PRISM AND LENS MAKING

By F. Twyman

THE managing director of Adam Hilger Ltd., Britain's outstanding precision optical producer, and inventor of the well-known Twyman interferometer, reveals in this new, compact text book the meat of what he has learned in a long lifetime about practical shop work. Content: Historical; elements of single lens working; nature of grinding and polishing; tools and materials; quantity production of lenses and prisms; centering, edging, and balsaming; making and working blocks of prisms; testing optical work; testing optical glass. The American optical industry has already sought this new book eagerly (roof-prism producers of amateur origin speak highly of it). Of what use would so expensive a book, ostensibly on professional quantity production, be to amateur telescope makers? To the tyro, almost none. Nor will advanced amateurs find it a full step-by-step manual It is more in the nature of a wide variety of notes, any single one of which may justify the purchase, a single short note often embodying the invaluable essence of years of costly shop experimentation, and as basically applicable and revealing in single-piece work as in mass production. It seems conservatively safe to predict that, eventually, hundreds—perhaps thousands—of advanced amateurs will place this excellent working aid next to "A. T. M. A." on their shelves. (178 pages, 5½ by 8½ inches, 63 illustrations.)—$4 60 postpaid —*A.G.I.*

FIGHTIN' OIL

By Harold L. Ickes

OIL, life-blood of civilization and particularly of modern military operations, is a far more complex subject than the average person appears to realize. Thus the thoughts of Mr. Ickes, set forth here in pungent, straight-from-the-shoulder exposition, are worth more than casual attention. The text surveys the need for oil, how to conserve it, how it is being used in a number of ways, and all the other ramifications of this important subject. (174 pages, 5½ by 8 inches, a few drawings and photographs.)—$1.75 postpaid.—*A.P.P.*

HARDNESS AND HARDNESS MEASUREMENTS

By Samuel R. Williams

METALLURGISTS and engineers long have dealt with hardness testing but largely on an empirical basis. Here for the first time a physicist seeks to go behind this basis and explain basic, fundamental research that leads toward the clarification of the subject. He rounds up and brings within compass of two

covers a vast amount of previously scattered data on: Theories and definitions of hardness; atomic structure in relation to hardness; underlying conditions in hardness measurements; wear resistance in relation to hardness; early, recent, and modern scratch methods; Brinell, Rockwell, and other methods, elastic properties as a measure of hardness; rebound methods; pendulum methods; tests on non-metals; portable testers; hardness and magnetic properties; magnetic methods; electrical methods; notes on manipulation; bibliography of about 1500 citations. A truly remarkable volume combining theoretical and practical. (558 pages, 6 by 8¾ inches, 340 illustrations.)—$7.60 postpaid.—*A.G.I.*

FIELD OF ACTION OF AIRCRAFT

By W. W. Smith

BASED on the discovery of a new method of solving all types of "radius of action" problems, and claimed to be simple for aerial navigators, this is a book of demonstrations and problems. (63 pages, 8½ by 11 inches, illustrated.) —$1.50 postpaid.—*J.P.C.*

SCIENCE YEARBOOK OF 1943

Edited by John D. Ratcliff

SELECTION of the 28 outstanding articles on medical research, aviation, natural history, and agriculture, published in 1942 in Reader's Digest, Saturday Evening Post, Atlantic Monthly, Colliers, Harpers, Fortune, American Magazine, Country Gentleman, Time, American Legion Magazine, Woman's Home Companion, and Scientific American, as chosen by John D. Ratcliff. Naturally, nearly all of these are on the more rather than the less popular side. (226 pages, 5½ by 8 inches, unillustrated.)—$2.60 postpaid. —*A.G.I.*

INDUSTRIAL RADIOLOGY

By St. John and Isenburger

PRACTICAL, working treatise on the use of X-rays and gamma rays for examining castings, forgings, and the like, for internal defects; it even includes cost data. It is the second edition of a book published in 1934 and under the slightly different title of "Industrial Radiography" the scope having now been broadened and the content brought up to date. (298 pages, 5¾ by 9 inches, 103 illustrations.)—$4.10 postpaid.—*J.P.C.*

HOW OUR ARMY GREW WINGS

By Charles DeForest Chandler, Late Colonel U.S. Army, and Frank P. Lahm, Brigadier General, U.S. Army, Retired

BOTH of the authors played distinguished personal parts throughout the development of Army aviation and are essentially fitted by experience, knowledge, and personal character to write an impartial, well-documented, and almost definitive account of the progress of our Air Corps. The book grew from voluminous notes and correspondence left by Colonel Chandler,

The Editors Recommend

Best Sellers in Science

PLASTICS — *By J. H. DuBois.* Meaty information on the whole general subject of plastics, presented in narrative form for easy reading. Tabulations of properties of plastics, plus basic design information, for laymen and technicians alike. $3.10

EXPERIMENTAL ELECTRONICS — *By Ralph H. Muller, R. L. Garman, and M. E. Droz.* A solid book of eminently practical information on the characteristics and non-communication applications of electron tubes. The text describes experiments and presents results. For students, radio engineers, communications experts, and the serious general reader. $4.75

HOW TO READ ELECTRICAL BLUEPRINTS — *By Gilbert M. Heine and Carl H. Dunlap.* A chapter on how blueprints are made, plus nine other sections, each of which is devoted to a specialized part of the electrical field, from bell and signal wiring through motor control diagrams to power station blueprints. $3.10

GET TOUGH! — *By Capt. W. E. Fairbairn.* How-to-win-in-hand-to-hand-fighting directions, by a man who really knows rough-and-tumble methods that are *not* "clean" fighting but *are* designed to win. $1.10

A COMPREHENSIVE SMALL ARMS MANUAL — *By Charles T. Haven.* Prepared to acquaint State Guards, Regular Police Depts., Coast Guard Auxiliaries, Plant Guards, Auxiliary Police Depts., and civilians with the operation, care, and limitations of weapons at present available for these types of defense and protective units. Discussion of all types of military and sporting rifles, shotguns, submachine guns pistols, and revolvers, as well as their care, use, and ammunition. $1.60

TECHNIQUE OF PLYWOOD — *By Charles B. Norris.* Technical information on all phases of plywood manufacture and use, compiled for engineers, designers, and users of plywood. Important to many phases of wartime housing and manufacturing problems. $2.50

FUNDAMENTALS OF RADIO — *By Jordan, Osterbrock, Pumphery, and Smeby.* With this one volume alone, and with some diligence of application, it is possible to obtain a thorough grounding in radio principles. In thoroughness of treatment, with due respect for the needs of the reader, this book is outstanding. $5.10

POPULAR MATHEMATICS — *By Denning Miller.* Anodyne for those who have mathematical indigestion. Ground treated is arithmetic, geometry, algebra, analytical geometry, trigonometry, conic sections, solid geometry spherical trigonometry, calculus. The coverage is not complete; it is rather, a collateral book—and good friend. $3.85

ELEMENTS OF ORDNANCE — A textbook prepared for cadets of the United States Military Academy. Covers manufacture, the chemistry of explosives, types of weapons, mathematics of ballistics, etc. $6.60

AIRCRAFT INSTRUMENTS — *By George Ellis Irvin.* All types of instruments for aircraft use described for students, pilots, inspectors. Fundamentals, instructions. $5.10

MARINE DIESEL HANDBOOK — *By Louis R. Ford, M.A.* A compendium of data on design, construction, and operation of the marine Diesel engine with chapters covering applications, principles, types, fuel injection systems, lubrication, supercharging, and so on. $7.25

MACHINERY'S HANDBOOK—*Eleventh Edition.* "Bible of the mechanical industry," enlarged to 1815 pages of latest standards, data, and information required daily in the shop and drafting room. $6.10

PROCEDURES IN EXPERIMENTAL PHYSICS — *By John Strong, Ph.D.* A wealth of useful data of a practical kind for the constructor, experimenter, and skilled craftsman. $6.30

STEEL SQUARE POCKET BOOK — *By Dwight L. Stoddard.* Practical methods of using the carpenter's steel square for layout work of all kinds. Time-tried methods used by two generations of carpenters and found both rapid and accurate. $1.00

REFINING PRECIOUS METAL WASTES — *By C. M. Hoke.* A practical book, based on experience, dealing with processing, identification, and repurification of such metals as gold, platinum, silver, alloys, iridium, and rhodium. $5.10

WORKING WITH THE MICROSCOPE — *By Julian D. Corrington.* For the serious beginner. Explicit, practical. $3.60

TOOL MAKING — *By C. B. Cole.* Instructions for making and using all kinds, from personal tools to arbor presses, lathes, planers, etc., in different metals. $3.60

THE ELECTRON MICROSCOPE — *By Burton and Kohl.* A well-written account of this newest tool of science, with all technicalities explained for complete understanding by average persons. $3.95

ENCYCLOPEDIA OF KNOTS AND FANCY ROPE WORK — *By Granmont and Hensel.* More knots are described in this remarkable book than in any book on seamanship ever published or dreamed of. 3257 knots are illustrated in half-tone reproduction and are described in the text. $5.10

A MATHEMATICS REFRESHER — *By A. Hooper.* Prepared mainly to refresh aviation trainees whose high school mathematics is rusty. Scope — arithmetic through calculus. $2.60

PLASTICS, PROBLEMS AND PROCESSES — *By Mansperger and Pepper.* The whole story of plastics, including a resume of manufacturing processes and a number of thorough-going chapters devoted to plastic uses $3.10

AUTOMATIC ARMS — *By Melvin M. Johnson and Charles T. Haven.* Comprehensively covers machine guns, machine rifles, sub-machine guns, pocket pistols, shotguns, sporting, military rifles in automatic classification. $5.10

BASIC FIELD MANUAL, INFANTRY DRILL REGULATIONS. Practical working manual for commissioned, non-commissioned officers. $.50

HANDBOOK OF CHEMISTRY AND PHYSICS — A classic reference book recently revised and brought up-to-date to keep pace with recent research. Includes material on all branches of chemistry, physics, and allied sciences. Used in laboratories and by engineers throughout the country. Flexible binding, 2503 pages. $4.10

ATOMIC ARTILLERY — *By John Kellock Robertson.* Electrons, protons, positrons, photons, neutrons, and cosmic rays, all described for the layman in plain language. Also transmutation of the elements and the manufacture of artificial radio activity. $2.35

The above prices are postpaid in the United States. Add, on foreign orders, 25¢ for postage on each book, except as noted.

For Sale by: September, 1943

SCIENTIFIC AMERICAN, 24 West 40th Street, New York 18, N. Y.

I enclose $.... for which please forward at once the following books:

....

....

Name ....

Address ....

Write us for information on books on any subject. We can supply any book in print.

who first conceived the idea of the book as an informal batch of reminiscences. Colonel Chandler's project became more ambitious as he went along and, fortunately, General Lahm could complete the work after Colonel Chandler's death.

The book is a fine record of great historic events, dealing with the pioneer period of Army aeronautics and ending appropriately with the Act of July 8, 1918, which approved formation of the Aviation Section of the Signal Corp. (333 pages, 32 illustrations.)—$3.85 postpaid.—*A.K.*

THESE MYSTERIOUS RAYS

By Alan L. Hart, M.D.

Radiology in medicine. Chatty, readable, non-technical discussion of the uses of X-rays and radium, chiefly in medicine. Anyone having a layman's interest in the things that doctors find out by means of X-rays would revel in this book. It tells in simple terms what the doctor finds when he X-rays you, and deals with numerous conditions and ills. (218 pages 5½ by 8 inches, 28 illustrations.)—$2.85 postpaid.—*A.G.I.*

AIRCRAFT ENGINE MAINTENANCE

By James H. Suddeth

In order to make this volume as complete as possible, the author has included not only those phases dealing strictly with maintenance, but also a thorough-going explanation of the construction and operating principles of the aircraft engine. Designed for mechanics, pilots, draftsmen, students, and so on. (372 pages, 6 by 9 inches, 268 illustrations.)—$2.85 postpaid.—*J.P.C.*

THIS EXCITING AIR

By Boone T. Guyton

The sub-title, "Experiences of a Test Pilot," correctly defines the subject matter of this small book. Mr. Guyton, who began his flying with the Navy, is one of the most experienced test pilots in the country and neither unduly glamourizes the art of test flying nor underates its dangers and difficulties. For a lay reader who wishes to know what a test pilot really does, this book will provide information and entertainment; a professional reader will add it to his stock of interesting flight yarns. (218 pages, 9 photographs.)—$2.10 postpaid. —*A.K.*

HUMANIZING BIBLICAL RELIGION

By William Floyd

Iconoclastic but not deliberately disputatious or blatant analysis of widely accepted beliefs, with a constructive statement of the secular philosophy of humanism based on natural law and an impersonal force in the universe, also on ethical conduct for a better life here and now on earth. This philosophy has much in common with those held by many scientists. (276 pages, 6 by 9 inches, one illustration.)—$2.10 postpaid. —*A.G.I.*

Printed in the U S A Press of the Wilson H Lee Company, Orange, Connecticut

Scientific American

Founded 1845

CONTENTS • OCTOBER 1943

SHOULD ERRORS creep into the graduations of the scale of an aircraft sextant, they would be multiplied hundreds of times in the calculations of the bomber or transport navigator who used the instrument. Thus the greatest possible precision is maintained in the engraving of these scales. On our front cover this month is shown a skilled worker at the Pioneer Instrument Division, Bendix Aircraft Corporation, setting the ingenious machine that does the engraving which eventually will safeguard lives and planes.

SCIENTIFIC AMERICAN, October, 1943 Vol 169, No 4. Owned and published by Munn & Co., Inc , Orson D Munn, President, I. Sheldon Tilney, Vice-President, John P Davis, Secretary-Treasurer, A. P. Peck, Assistant Secretary; all at 24 West 40th Street, New York 18, N. Y Entered at the New York, New York, Post Office as second class matter June 28, 1879, under the act of March 3, 1879. Additional entry at Orange, Connecticut. Published monthly by Munn & Co, Inc., 24 West 40th Street, New York 18, N Y

Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage. Illustrated articles must not be reproduced without written permission; quotations therefrom for stockselling enterprises are never authorized. Files in all large libraries; articles are indexed in all leading indices. Subscription rate $4 00 per year. Canada and foreign $5.00.

Previews of the

A. P. Peck

WHEN THE WAR ENDS

So-called "informed circles" in Washington are predicting the end of Germany by next summer at the latest, perhaps by next spring, maybe even by the end of 1943. Then another year of war with Japan and . . . the post-war era. Nothing will be read into such predictions, by the intelligent person, which will in one iota affect our present schedules of production for the military forces. They do, however, bring home forcefully the need for even more intensive thinking on those problems of the post-war world which must be prepared for in advance if they are to be met with any degree of success.

The period of transition from military to civilian production is going to be a painful one. Transition periods almost invariably are painful. Yet the pain—and even more serious consequences—can be reduced to a minimum by the exercise of a degree of foresightedness seasoned with a knowledge of those advances in science and technology which have grown out of war-driven research.

Now, then, is the time to start planning for the future, if it has not already been initiated. So far the Government is not looking with too great favor on such planning by individuals and private industry, although Government itself is doing some of it in a way that many think to be impractical. The fear seems to be that post-war planning will slow up present production. Such fears, for the most part, are groundless or worse. The company which has placed its war-time operations on a sound working basis and has given some of its attention to the future knows that it has a great stake in the peace to come. With this knowledge it will certainly continue to strive for the greatest production which, in turn, will mean the earliest possible end of the war. And when the corner is reached, the companies in this category will be in the strongest positions to face reconversion with a minimum of upheaval within their own organization ranks.

If events follow the path predicted by the "informed circles," war production will probably taper off somewhat after the fall of Germany. No immediate drop is to be foreseen, but the trend will undoubtedly be generally downward in many industries. This will give a period—perhaps the year previously mentioned as being the time required for the finish of Japan—during which some of the post-war plans can start to operate. If they have been polished to a point where they are workable, everyone will benefit. If they are allowed to languish and are put off until needed, they will not be ready for use and many people—employers and employees alike—will suffer.

On post-war planning will industry stand or fall as the guiding force of the American way of life.

SUBSCRIBERS to Scientific American will notice that the present issue was delivered to them without the usual paper wrapping, and with the address on a slip pasted to the front cover. This method of mailing has been necessitated by the current shortage in wrapping paper and will be continued only as long as absolutely necessary. We know that it is not as satisfactory in many respects, but are sure that our subscribers will bear with us until such time as wrapping of mailed issues can be resumed.—*The Editor.*

WHENCE RUBBER IN THE FUTURE?

When considering the problem of whether our future rubber supplies will come from the test tube or the rubber tree, one fact that is often lost in the shuffle is that natural rubber can be produced to special specifications, much as can the product of chemical ingenuity. This, plus the adaptibility of rubber raising to small-scale farming operation, will have a definite effect on the post-war rubber economy. For more details, see page 169.

INDUSTRIAL DERMATITIS

Increasing attention is being given by medical science to skin and other diseases directly attributable to conditions under which industrial workers are employed. Recently, for example, there have been outbreaks of "glue itch" among employees in plywood and laminating plants, causing great amounts of lost time on important war work. This skin trouble has been directly traced to irritating substances in the glue. And the troubles have not been confined to workers using urea-formaldehyde and phenol-formaldehyde adhesives but have also been found among those exposed to the effects of other more common glues to which irritating chemicals have been added.

Such occurrences as those outbreaks of glue itch point definitely to a responsibility which industry has, not only to employees as individuals but to the nation as a whole. Not until the war is over can the production of military goods be relaxed for a moment, except as changes in military operations dictate. Not at any time should employees be exposed to conditions that can effect their health until every precaution has been taken to remedy these conditions, to prevent outbreaks of disease, or to provide adequate treatment for those affected.

Medical science is prepared to cope with problems of these types; with the co-operation of industry much can be accomplished.

SILVER LINING

Coming up rapidly as an industrial metal is silver, yet this important development work has found a number of stumbling blocks in the form of political chicanery, much of which dates back into the early days of silver mining in the United States. In those days, when the uses of silver were limited to coining and decorative activities, the motives of politicians in building the fences which they erected around this precious metal were of little moment to the industrial world.

Today, however, science has shown many new uses for silver, some of them highly important to the war effort, all of them based on jobs which silver can do as well as or better than other materials. In the future, and this will be especially true if the politicians awaken to the facts of life, silver will be widely used in the electrical, chemical, metallurgical, and other industries, following the lines detailed in the article starting on page 151 of this issue.

AIRPLANES OF THE FUTURE

American industry has proved that it can produce airplanes rapidly and in large quantities. These planes are being flown in all kinds of weather in many parts of the globe. On such facts are being built over-optimistic pictures of the future of aircraft as far as the average man is concerned. Planes that he can fly with little more instruction than needed to master the driving of an automobile are entirely possible. They can be made cheap enough to meet his pocketbook. But at low prices they cannot possibly be equipped with the intricate and delicate instruments so necessary for flying under all conceivable conditions. Add to this the terrifying prospect of airways crowded with planes and the over-optimistic pictures will take on a greater shade of reality — and of fewer planes for civilian flying.

This is not to say that there will be no market for private planes in the future. There certainly will be, but from where we sit we can see no immediate prospect of a plane in every back-yard. The future of aviation seems pretty clear at the moment: Huge development of aerial trans-

portation of passengers, mail, express, and cargo (see page 154), handled by competent organizations on well defined airways; and a renewal on an increasingly large scale of the interest in sport flying that was gaining ground rapidly before the war. But planes for every commuter, for week-end trips to the mountains or the seashore, for all the uses to which the family automobile is put, is stretching things a bit too far until a great deal of additional development work is done on fool-proof automatic control of planes and aerial traffic.

FOR GREATEST FLEXIBILITY

In the earliest days of electrical transmission of power, direct current had the field to itself. Then came the development of alternating current, with attendant economy and flexibility. Despite technological progress, however, certain appliances (notably motors) designed for D.C. operation gave better performance for some purposes than did those for A.C. use. And they still do. Nevertheless, A.C. power forged ahead, virtually leaving such appliances to shift for themselves. Now comes a development in the field of electronics to bring to unit motor users all of the advantages of a D.C. machine with the desirable features of A.C. distribution of power. For details see page 166. This industrial adaptation of a principle of electronics is sure to influence machine design in many respects, to bring greater flexibility to electrically driven equipment, to spread the use of unit motors to operations to which they could not heretofore be applied, either because of the lack of a D.C. source or because A.C motors were not satisfactory.

A PLASTIC OF THE FUTURE

Good news for post-war manufacturers of certain consumer goods comes from the Du Pont Company. Engineers and designers, they say, who never before the war worked with the crystal-clear plastic Lucite have, incidental to war production, developed uses for this material which can be applied on a production basis to the fabrication of such products as furniture, automobiles, refrigerators and other household appliances, display signs, industrial equipment, and so on.

These applications, in addition to uses in commercial air-transport planes, following practices developed for war-time ships, will open broad horizons for clear plastics. As their properties are more thoroughly investigated by the probing finger of restless research, and their mechanical possibilities are tested under even more varied conditions, they will undoubtedly pop up in unexpected places in the home, the factory, and the business office.

JUST AROUND THE CORNER

Some day television will be the basis of a great industry. Many of the technical problems have been solved, in the laboratory and in the field, but there is much more to the whole subject than just this. There are economic problems of tremendous magnitude which must be solved before television will be anything more than an interesting novelty to a few scattered owners of receivers. This situation will hold true until such time as a means is found for paying for the programs. These statements are based on reports from E. F. McDonald, Jr., president of the Zenith Radio Corporation. On the other hand, Ralph R. Beal, Research Director for the Radio Corporation of America, has recently stated that television will be ready for every family's use "immediately after the war."

The difference between "technically ready" television and satisfactory television programs day in and day out is a factor in the whole television situation which must not be overlooked. Science and industry will be ready to produce receivers as soon as they are permitted to do so when peace comes. However, the time when adequate programs will be available seems still to be far off on the horizon.

EARNING WHILE LEARNING

An education plan which might well be applied in other localities and to men as well as to women is now in operation at Shurtleff College. Here girls are given an opportunity to pay for their education by working alternate three-month periods in the plant of the Western Cartridge Company and going to school in the intervening three-month periods. Usual procedure is for the girls to be paired off so that one is working while the other is attending classes. Thus the plant has the uninterrupted services of a productive worker and the college can maintain its classes and teaching staff at maximum efficiency.

MORE ON METALS

In these columns last month we dealt with the possibilities of the light metals in the future and of the steps which the steel industry is taking to hold its own place in various fields. To this discussion should be added further notes in order to round out the picture.

While the light metals — aluminum, magnesium, and their alloys — will find uses in the automobile of the future, steel will undoubtedly remain the predominant motor-car fabricating material, especially in the low-price field. Then, in the manufacture of aircraft, there must be considered the possibilities of steel and plywood combinations and of aluminized steel to meet certain specifications. Today, emphasis in aircraft construction is on high strength combined with light weight, the weight factor influencing such characteristics as maneuverability, gasoline load, ammunitions and bombs carried, and so on. Tomorrow, in the transports and cargo ships, strength will still be needed but there will not be the life-and-death aspects of light weight Under these conditions, steel will become a much more serious competitor in the airplane field than it is today.

TOMORROW'S FABRICS

One of the fields that rubber, whether synthetic or natural, is going to lose, at least in large part, to other substances, is that of water-proofing As a result of huge demands by the Army for weather-proof clothing, textile-coating materials made from synthetic resins and similar products of the laboratory have been applied with great success. In many respects these new fabrics are better than the rubberized ones which they replace. They withstand tremendous fluctuations in temperature, resist the effects of gas and oil, and are subject to less deterioration under the direct rays of the sun. Add to these desirable characteristics the fact that these new fabrics can be made lighter in weight and more flexible, and there is seen a future consumer market of sizeable proportion.

KEEPING DOWN THE DUST

Closely linked with problems of industrial diseases, mentioned in a previous paragraph, is the matter of dust in industry. Through the application of recognized methods of dust control (see page 157), many industries are not only reducing the incidence of respiratory troubles among workers, but are, in some cases, recovering valuable materials from process dusts that otherwise would be thrown to the winds.

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of October, 1893)

GERM WARFARE — "Experiments have been recently made in Germany to ascertain if rifle bullets can carry infection. . . . Investigations show that if rifle bullets are purposely brought in contact with micro-organisms and then discharged in the usual way they carry the microbes with them into whatever material they subsequently penetrate; the microbes, moreover, suffer no damage and grow as abundantly as ever."

FIREFIGHTING — "The settlement of this country has been followed by fires of unparalleled magnitude, which may be regarded as a natural consequence of the rapid growth of the country. . . . It is a popular belief that every man who is able-bodied is fit to fight fire, but this is erroneous. . . What we need is a school for fire extinguishment, where systematic training can be given in the science and methods. Such a school would dignify a calling until it reaches the stage of a profession, and would render life and property more secure. The firemen of the United States are, without doubt, the best in the world, but there is still abundant room for improvement."

RAILROADING — "The Chicago flier is not driven by one but by many engineers. . . . In order to cover the 964 miles between the two cites in twenty hours, including nine stops, there are required seven huge engines in relays, driven by seven grimy heroes. A run of less than one hundred and fifty miles is the limit per day for each engine, while three hours of the plunging rush wears out the strongest engineer."

ARGENTINE DEVELOPMENT — "The national government of the Argentine Republic and the provincial government of Buenos Aires have granted concessions to Messrs. Gibson & Co., to construct a port at San Clemente, Cape San Antonio, in the province of Buenos Aires, and railways to connect the port with the existing railway system. . . . The first section of the projected works includes an entrance channel having a depth of 29.5 feet at low water and 34.4 feet at high water. The breadth at low water is to be 311 feet. A mole, 5,578 feet long, will inclose the harbor on the west. Other quays are to be built. There is no special difficulty with the railways, which it is hoped will open up a large and fertile zone of the province"

OIL — "The depth at which oil is found [in recently developed Peruvian oil fields] . . . . is not over 500 feet, whereas in the United States the depth is from 2,000 to 3,000 feet. The distilled product is sold along the coast, while the crude oil has a large sale at Callao for use by the gas companies, for stationary engines, and for the railway locomotives, as a substitute for coal."

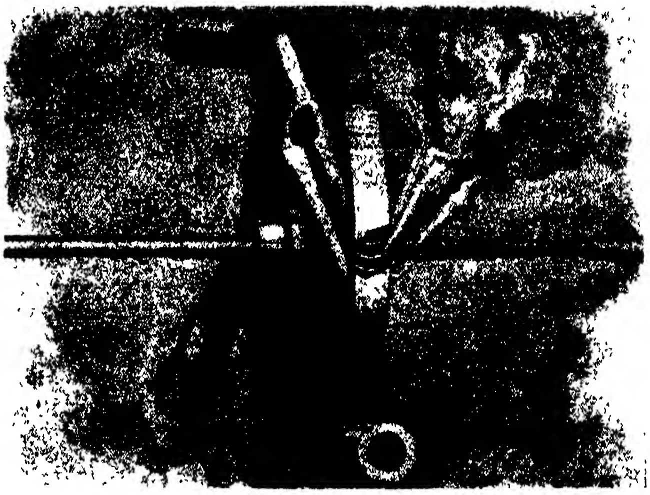
PATENTS — "We regret that not a single member of Congress has brought forward a bill to facilitate, protect, or assist the innocent inventor in securing reasonable rewards for his labors in benefiting the country by discovering new processes and inventions. It seems to us the true policy is to pass laws to foster, encourage and promote the establishment of new industries, not to break down and chastise the authors and inventors thereof."

STEAMSHIP SPEED — "Mr. J. H. Biles, the designer of the Paris and New York, suggests the possibility of 30 knot steamers in the future. Ten knots must be added to the present speeds. Of this Mr. Biles proposes to gain two knots by the use of nickel steel instead of ordinary steel, then three and a half knots by the use of oil instead of coal as a fuel, and the remaining four and a half knots he believes can be secured by such changes in dimensions as will increase the length and draught and by improving the machinery. The length will be about 1,000 ft, and the beam 100 ft., with a draught of 30 ft."

BREAD AND SOAP — "From a communication read to the Association of Belgian Chemists, it seems that Continental bakers are in the habit of mixing soap with their dough to make their bread and pastry nice and light. The quantity of soap used varies greatly. In fancy articles, like waffles and fritters, it is much larger than in bread."

GAS LIGHTS — "The gas used in lighting the Broadway Cable Cars . . . . as well as all cars using the Pintsch system, is made from crude petroleum . . . . from which a very rich gas of over 70 candle power is obtained, and which will stand a very high degree of compression without materially affecting its illuminating qualities."

TURBINE — "De Laval's steam turbine, which forms the subject of our illustration, is in principle exactly similar to the well-known axial jet turbine for water. . . . The steam passes between the blades of the turbine at a constant relative velocity and in a clear jet, without any disposition to further change its pressure or specific gravity . . . The blades against which the steam strikes are made thin at the edge to reduce the resistance to the flow of steam In this turbine steam is expanded to the pressure of the surrounding medium before arriving at the blades. This expansion takes place in the nozzle, and is caused by making the sides of the nozzle divergent. As the steam passes through the nozzle its volume is increased in greater proportion than the cross section of the jet, thus causing an increase in velocity. With an initial pressure of seventy-five pounds, and an expansion to the pressure of one atmosphere, the final velocity of the steam is about two thousand six hundred and twenty-five feet per second. . . . Expansion is carried much further in this turbine than in ordinary steam engines"



TORPEDO BOATS — "Considerable interest is being taken in the new torpedo boats which are now being constructed, two at the New York navy yard for the Maine and two others at the Norfolk navy yard for the Texas. The boats are built as light as possible, so that they can be easily hoisted on board the large vessels. . . . The two boats for the Maine will each be fitted with a bow tube for discharging an 18 inch Whitehead torpedo and the two boats for the Texas will each be fitted with a deck training tube for a torpedo of the same size. Each boat will carry a 1-pounder rapid-fire gun."

STOCKINGS — "The enterprise and skill of American silk hosiery manufacturers has, it is represented, very nearly driven the foreign lisle thread stocking out of the market."


Joe needs
the Long Distance
lines tonight

"Quotes . . ."

"IT WOULD be little short of a catastrophe if, in case the war should end tomorrow, the vast onward sweep of our technological war developments should be stopped in mid-air." *Dr. Charles Kenneth Leith, Office of Production Research and Development of the War Production Board.*

" " "

"IN A COUNTRY such as ours, free enterprise supports us all, the government functioning as the referee of the rules prescribed for the conduct of the game of business." Harold Vinton Coes, Vice-President of Ford, Bacon and Davis, Inc.

" " "

"SO FAR as the building industry is concerned, it is now, for the first time, beginning to have the technological skill to build homes within the income-reach of nearly all of the American people. . . The building industry is now on the threshold of a new frontier Mass production." *Bror Dahlberg, President, The Celotex Corporation.*

" " "

"THE WAR, if it demonstrates anything, demonstrates that mankind as a whole is morally and politically unfit to apply the knowledge which science has placed at its command." Dr. Willard H. Dow, President and General Manager, The Dow Chemical Company.

" " "

"NO GREAT new engineering principles have come out of the war but many new developments have come from recognized engineering principles." *Alfred P. Sloan, Jr., Chairman of the Board, General Motors Corporation.*

" " "

"THE WHOLE job of war production is geared to the speed of the slowest producer. It is this slow producer who needs our help, for if he is a maker of one part of a weapon, that weapon only gets to the firing line with the speed at which he operates." Alvin E. Dodd, President, American Management Association.

" " "

"OUR PSYCHOLOGICAL front should be as powerful, as dynamic, as our economic and military fronts. It can destroy the morale of the enemy, his belief in himself and in his myths. It can win the good will of non-belligerents, so important now and in the post-war world." *Edward L. Bernays, Counsel on Public Relations.*

" " "

"IF SAVING civilization has depended upon the production of war supplies in amounts needed, when needed, then it has been the sprawling giant of American industry, its managers and labor, which saved it." David Hinshaw in "The Home Front."

METALS IN INDUSTRY

Conducted by FRED P. PETERS

Photographs with this article courtesy Handy and Harman

Pouring molten silver into a crucible preparatory to making wire bars

Silver in Peace and War

The Irresistible Technical Force of Silver's Wartime Development As an Industrial Raw Material Has Crashed into an Immovable Political Wall. Full Utilization of this Metal's Post-War Industrial Potentialities Can Come Only With Public Enlightenment on Both Phases

America's most misunderstood war material today is silver. The public, which thinks of silver as something used solely for dimes and quarters, tableware and jewelry, sadly underrates it and is completely at sea on "the silver question" as a political issue Politicians and producers who regard the currency-backing use for silver as its major "market" are blind to its real potentialities. And industrialists who are unaware that silver is a superlative bearing material, a useful ingredient of electrical contacts, and a remarkably ubiquitous jointing metal in war production are doing justice neither to their own operations nor to silver itself.

But, for all its present utility in the manufacture of warplanes, communications equipment, and munitions in general—and despite its promises as a post-war material—silver is at this moment one of our most celebrated political footballs. It is now under WPB control, although a vast hoard of it remains unused in this country, and under a recent order it must be sold to industry *at two widely distant price levels for the same quality material*, depending on the end-use.

Public opinion *could* force a correction of the silver situation. Already the pressure of technical development and industrial demand have broken down a few barriers to employment of the Treasury's silver accumulation for war purposes. But before the full voice of the public can be heard it must "understand" silver—both as an industrial material *and* as a political issue.

To comprehend fully the new position of silver one must examine its status before war needs revealed its industrial adaptability. In 1939 the United States consumed a total of 54 million troy ounces of silver, of which 20 million ounces was used to make silver coins and 34 million ounces went into silverware, photography, and general industrial uses. The significant point is that these general industrial uses accounted then for less than 6 million ounces (about 200 tons). Silver was predominantly employed for either coinage or luxury items—it was a typical glamour metal, with virtually half of its consumption assigned to ornamental uses.

The years of peace had brought something else to American silver—a magnanimous customer who purchased all the silver United States mines could produce, as fast as (even faster than) they mined it and at a price about double that obtainable from any commonsense manufacturer, and who then stored it away in vaults and forbade its use for any productive purpose. This customer was the United States Treasury, which was required by law to pay a high premium for newly-mined domestic silver and store it so that some day the monetary values of the Treasury's silver and gold stocks would be in the ratio of 1 silver to 3 gold. (The ratio is now about 1 to 5)

This premium price was in the neighborhood of 70 cents an ounce (it was fixed in 1939 at 71.11 cents) and foreign silver could be bought by American users in world markets for about 35 cents an ounce. They naturally made no attempt to overbid the Treasury department for American silver when the foreign metal was so much cheaper and, as a consequence, for the eight years prior to 1942 the arts and industries in the United States had been using only silver of foreign origin. In other words, 1939's industrial consumption of 34 million ounces of silver was based entirely on imported metal.

But during all the time the Government's silver-purchase program was apparently becoming more firmly entrenched (to the delight of the "silver state" senators), scientists and engineers were learning things about silver and doing things with it that we

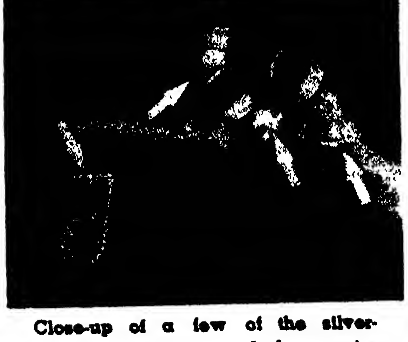
ultimately to change the whole situation. The silver producers themselves sponsored research on the properties of and possibilities in silver for industrial use. Pure silver was discovered to have the "slipperiness" expected of a good bearing metal, combined with the corrosion resistance desired for modern aircraft and automotive engine service. Silver-lined containers and silver-clad vessels increased in use for holding certain corrosive chemicals. Powder metallurgy opened up the field for silver in electrical contacts, since by this new technique desirable but otherwise not-producible combinations of silver with nickel, molybdenum, or tungsten could be achieved. And the use of silver brazing ("hard soldering") alloys grew with astonishing rapidity as their advantages of low-temperature but high-strength joints became more widely recognized.

By the time the war struck America, all these trends had reached so far that silver behaved at its impact like any other industrial raw material. The consumption of silver was heavily expanded by virtue of the general expansion of all those industries already using it. At the same time the war created a sudden demand for large amounts of silver as a substitute for critically scarce metals and coatings such as nickel, chromium, and copper.

And, as one might expect, the irresistible technical force crashed into the immovable political wall. The supply of foreign silver was found insufficient for the new industrial demand, and pressure was put on the Government to repeal or modify the silver-purchase laws so that both domestic silver production and treasury stocks not required for currency backing could be used to fulfill the painfully heavy industrial requirements at a reasonable price level.

Domestic silver production (remember: This silver was chiefly *not* used by industry) in 1942 was 54 million ounces. The Treasury stocks not required for currency backing are *over a billion ounces* at this writing. The "silver bloc" in Congress has nonetheless refused to permit the abandonment of the silver-purchase program and legislation so that this hoard might become freely available to industry.

But great gains have been made in recent months and part of both the silver hoard and domestic production are finding restricted use in industry.



Close-up of a few of the silver-brazed joints on an airplane motor ignition shield. Steel brackets and brass tubing and outlets are used

Thousands of tons of Treasury silver stock have been consigned to the Defense Plant Corporation to be substituted for copper and aluminum as bus bars and in other applications where the silver is not consumed or destroyed. Nearly three million ounces of silver were used in the new "silver nickels," thus freeing large amounts of nickel for other uses.

Finally, in July of this year, the controversial Green bill became law, and by its terms and under a subsequent WPB order (1) silver from the Treasury stock may be sold to industry at 71.11 cents an ounce for use only in engine bearings, military insignia, brazing alloys, and solders—under WPB control, and (2) foreign silver, which now costs 45 cents an ounce, may be used for making electrical contacts, photographic materials, miscellaneous high-priority products, and medicines. To carry the extra cost of the high-priced silver, a bearing manufacturer, for example, is now permitted to break his O.P.A. price ceiling on the finished bearing and pass the extra price of his silver on to his customer.

THIS SKETCHY political background has been presented in an article on technical developments because the technical and political phases of silver's history in our times have been inextricably woven. The influence on postwar industry of the war-winning applications of silver now to be described can be great or small according to the political handling of silver in the months to come.

Silver has served the ends of Victory in two ways—as a replacement for tin, copper, and other critical materials and in its own right for mechanical or electrical parts that function best when silver or its alloys are used. Actually, in certain of the "substitute" applications, too, silver alloys are turning out to be superior and will someday present a serious challenge to the metals they now replace—if the price situation permits it.

A typical "for the duration" application of silver is its new use as bus bars in aluminum and magnesium reduction plants. The bus bars are heavy-gage bars of pure metal that conduct the electric current from the power-supply substations to the electrolytic refining cells. They are normally constructed of pure copper or pure aluminum; when silver is employed without redesigning the system the weight of the conductor is heavier than with copper, since the two metals have similar conductivities (silver is slightly higher) on a volume basis, but silver's density is about 18 percent higher.

The silver for this purpose is lent by the Treasury department to the Defense Plant Corporation, who may use it only in Government-owned or operated plants and must return every ounce of it within five years. One of the most recent silver bus-bar installations is at one of the Dow Magnesium Corporation's plants, where 900 tons of it, worth over 18 million dollars at the *Treasury's* price of 71.11 cents per ounce, must be kept constantly under armed guard. One understands immediately why silver for bus bars is an emergency use alone.

The use of silver in the new "silver nickels" will almost certainly end with war's termination. Close to three million ounces of silver have already been consumed in making these new coins. (They contain 56 percent copper, 35 percent silver, and 9 percent manganese and have a "P" mint-mark on one side.) This is a lot of silver but the amount of copper or nickel saved is still only a small portion of the total copper or nickel tonnage.

The standard "nickels" contained 25 percent nickel and 75 copper. Original substitution plans called for a Victory

Typical silver contacts used by industry for a wide variety of services

"nickel" of 50 silver, 50 copper, which would have had about the same color and coining properties as the old nickel. But it was found that this straight silver-copper "nickel" had too high a conductiviy to operate the coin boxes in several types of vending machines, subway turnstiles, telephone pay stations, and so on, and the present composition, containing less silver and some manganese and having electrical resistance and magnetic properties similar to those of the old "nickels," was developed.

Silver is employed in bearings in two ways: In the form of silver-clad or silver-plated steel or silver-base alloys, and as a constituent of lead-base alloys developed to replace bearing metals containing large amounts of tin.

Fine-silver is used in the main bearings and connecting-rod bearings of several types of aircraft engines because of its superior performance and engineering economies. A thickness of about 25 thousandths of an inch of silver or a silver-lead alloy is joined to a steel backing. This combination provides the mechanical strength in thin sections beloved of aircraft designers, plus the embedability (the property of "absorbing" grit instead of being scored by it), corrosion-resistance, and "oiliness" of the silver. The friction properties of pure silver are similar to those of lead, tin, and cadmium, but it has a higher melting point than any of these and—what is especially important in engine-bearing service—unusually good fatigue resistance.

Actually, pure silver is not the "oiliest" bearing metal available, and on ground shafts it has some tendency to "seize." The addition of a few percent of lead, however, seems to improve its bearing qualities considerably, although

the bond between silver-lead and steel is weaker than that between fine-silver and steel. Pure silver bearings run ideally against a polished shaft.

Silver bearings in aircraft engines are electroplated, cast, or rolled on to the steel backing. Although the cost of silver bearings might be expected to be high, actually they often cost little more than comparable bearings of other types (especially if the silver coating is produced by electroplating and is therefore very thin), because the cost of the silver in a bearing is only a small proportion of the total material-plus-production cost of the part.

A "substitution" use for silver in the bearings field is its presence as an essential constituent in a class of lead-base babbitt metals being offered in place of conventional tin-base babbitts containing over 85 percent tin. Lead babbitts have widely replaced tin, since tin is relatively much scarcer, and lead babbitts with 2 to 5 percent silver approach the properties of tin-base babbitts more closely than other substitutes that have been proposed or used.

The tin-conservation performance of silver in the solder field can be summarized in the statement that 2½ percent of silver can replace 30 percent of tin. The favorite substitute solder today is one containing 97.5 percent lead and 2.5 percent silver, which replaces lead-tin solders containing more than 30 percent tin. The "substitute" solder, now that the technique of using it has been mastered, is developing a strong

Steel solenoid housings and saddles are cleaned and fluxed, then assembled with a thin strip of silver brazing alloy between them. Heat is then applied, as shown, to melt the alloy and complete the joint

preference in its own right among many users and may be the "standard" solder of commerce in years to come.

The reasons for this are interesting. Although they must be applied at a higher temperature than standard solders (675 to 775 degrees, Fahrenheit, against 450 to 575 degrees) and require more active fluxes, the lead-silver solders can produce stronger joints than lead-tin solders *and are no more costly.* In the words of a recent War Metallurgy Committee report to WPB, "either at present pegged prices or at normal prices under ample supplies of tin and silver, the lead-silver solder is no more expensive in raw material cost than the 60-lead 40-tin solder previously used."

The major uses for solder in normal years were for dip-soldering automobile radiators, for electrical connections, and for soldering tin cans. In wartime the latter use emerged as one of the toughest substitution nuts to crack, but the can-makers have been extremely co-operative. They are now employing the lead-silver solders even on their automatic soldering machinery that was designed for the standard solder's lower application temperature and wider freezing range. (The lead-silver solders go from the liquid to the solid state quite rapidly, without a "pasty" period.) Some can-makers *prefer* the lead-silver solder on can bodies that have been made from the new electrolytic tinplate, because the side-seam strength is higher. This is significant, because the use of electrolytic plate is expected to surpass that of hot-dipped plate in the post-war period.

The War Metallurgy Committee's investigations lead, finally, to the conclusion that the lead-silver solder for food cans involves no health hazard and is entirely safe even for evaporated milk, so widely used for infant feeding.

Lead-silver solders containing ¼ percent copper have long been used in the electrical field, and solders with 4 to 5 percent silver were and are standard for automotive radiator dip-soldering, in both cases because of their better strength at the elevated operating temperatures encountered.

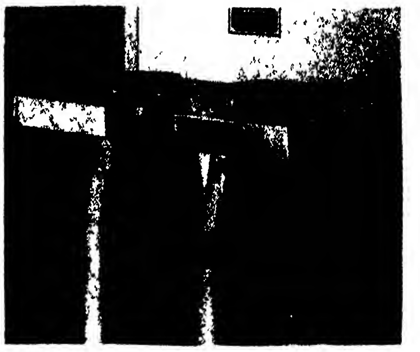
The war has brought a sharp increase in the use of silver in electrical contacts—those small metal parts that permit current to pass in a circuit when pressed together and whose separation leaves the circuit open. Contacts take the form of switch points, flat springs, nibs, screws, and so on. Some contacts are pure metals, some alloys, some bimetallic strips (two layers of different metals) and some pressed from powder to yield a duplex structure.

ENGINEERS are generally agreed that an ideal contact material would be one with the electrical conductivity, heat conductivity, low arc-resistance, resistance to oxidation and workability of silver, and the hardness and low material-transfer during arcing of tungsten. Approaches to this ideal are available in silver-tungsten contacts made by pressing and sintering mixtures of silver powder and tungsten powder to give a finished structure in which the individual properties of the two metals are largely retained

Similarly, silver-molybdenum contacts made by powder metallurgy are employed where the utmost resistance to oxidation is not required and where molybdenum's aid in correcting the tendency of silver to evaporate at high currents can be utilized.

Considerable attention has recently been paid to laminated or bi-metallic contacts, two-layer contact strips of silver on a copper backing or of sintered silver-nickel, silver-molybdenum or silver-tungsten on copper.

Silver contacts of various types are



Leak-proof joints between steel shell bodies and adapters are rapidly made by induction-brazing with silver alloy, using this heating set-up

used in aircraft control devices, communications equipment and switches, circuit breakers, relays, and temperature control systems for a variety of purposes.

The phenomenal expansion in the use of silver brazing in the last decade, and particularly since war production began on a large scale, has reflected a positive interest in this joining method as a faster, less-expensive means of fabrication and not as a substitute. According to Handy and Harman, New York silver bullion dealers, since the start of the war tons of this material have been used where merely ounces were required in peacetime. Millions of silver-brazed joints are now being made every month.

Silver-brazing alloys are basically alloys of silver, copper, and zinc that contain 10 to 50 percent silver and melt at temperatures as low as 1175 degrees, Fahrenheit. The brazed joints are made by bringing the parts to be joined closely together, with a rod, strip, disk, ring, or powder of the brazing alloy at the joint, then heating the joint area to slightly above the melting temperature of the brazing alloy by torch, induction heating, incandescent carbon, or by passing through a furnace or dipping in a hot liquid bath, and cooling. Properly designed silver-brazed joints usually have the strength of the solid metal and give the added advantage of being made at low temperatures. This means either faster production or lower heating costs, or both, and often permits the brazing of parts or tools that cannot be heated to temperatures above 1300 degrees, Fahrenheit, without destroying their useful properties.

A modern airplane has over 400 silver-alloy brazed parts, and every torpedo has several hundred brazed joints. A large ship contains over eight miles of piping that is joined with silver alloy rings. According to one authority the greatest single war use of silver brazing alloys is in the manufacture of bombs and shells. Sections of the 20mm and 40mm guns, the water-jacket of the Bofors guns, and even parts for the latest bombsights are silver-brazed.

A vital contribution of silver brazing to war production is its wide use for repairing hardened high-speed steel tools, which are costly *and time-consuming* to replace with new tools, but

(*Continued on page 182*)

Conducted by ALEXANDER KLEMIN

Airlines of the United States, though they have yielded much equipment to the Army, are today carrying more passengers, mail, and express than ever before in purely commercial operation. Growth of such operations has ceased for the time being because no new equipment is obtainable, but in the post-war period we may expect a tremendous increase in airline activities

Tomorrow's Air Transport Planes

There Are Many Reasons Why There Will be Great Increases in Airline Activities After the War. A Preview is Given Here of the Plane Types Which, it Now Appears, Will Carry Passengers and Cargo in Large Volumes and in Safety and Comfort at High Speeds

for very definite reasons: War aviation will have broken down all resistance to air travel; flight and ground personnel will be available in large numbers; and war aviation equipment—planes and engines—will be convertible in important numbers and at low prices to the uses of peace.

It is time, therefore, for operators and engineers to speculate on the characteristics of the post-war transport airplane. Timely utterances on the subject have been made by such distinguished men as Charles Froesch, Chief Engineer of Eastern Air Lines, speaking before the Society of Automotive Engineers; Jerome C. Hunsaker, Chairman of the National Advisory Committee for Aeronautics; and W. W. Davies, of United Air Lines, delivering a paper before the American Society of Mechanical Engineers.

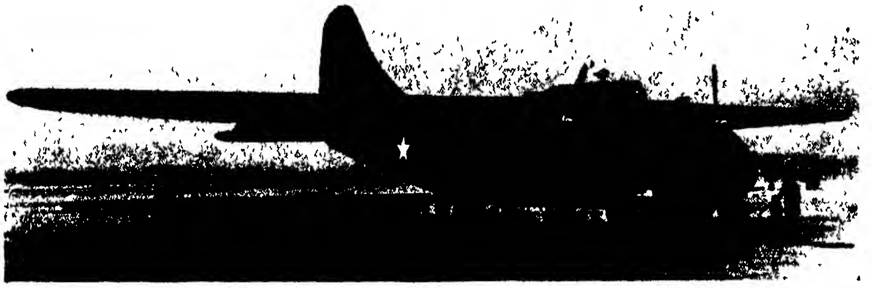
Mr. Froesch perhaps gives the most vivid picture of what is being learned in current air-transport operations, particularly in those of a military character. Because war brooks no denial, risks are taken and lessons are learned which peace would not have taught us for many years. Thus, under the drive of war, airplanes have been flown at gross weights far in excess of those for which they were certificated, yet for the most part without disaster. This has led to the conclusion that wings can be loaded to as high as 50 pounds per square foot of wing area—a fantastic figure only a few years ago.

Powerful engines have come, with single units delivering up to 3000 horsepower. The combination of high wing loading, higher power, and greater airplane size has shown that a greater percentage of payload, and higher speeds, can be obtained than those which were available before the war.

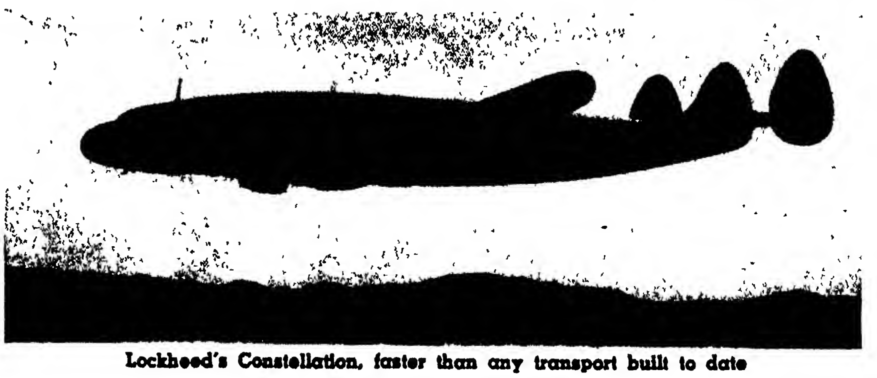
Because the Army and Navy needed high-octane fuels in huge quantities, the oil industry has learned to produce these wonderful fuels on a mass production basis at relatively low cost. Because military transport planes have at times to operate in rough and restricted terrain, the tricycle or nose-wheel landing gear has became an absolute necessity. Because the Army and Navy requires transportation of heavy engines, guns, even tanks, and every known variety of equipment to the farthest corners of the earth, we have learned that air cargo can be anything, that it can be loaded and unloaded quickly and secured in the cargo compartment against the most violent gusts and landings. Because the German army flew gliders into Crete, and the United Nations into Sicily, there is reason to believe that towed gliders will be utilized to some degree in post-war operations. Radar, submarine detection, innumerable war uses of short-wave radio, have given us perfect means for guiding and landing aircraft no matter what darkness or fog may prevail. And, finally, the need for huge numbers of bombers has taught us how to build planes and engines on a scale and at a cost which would have been unbelievable just two or three years ago.

All of the above are lessons of war transportation. There is no ultimate benefit from any war, but war-inspired research can hasten technological advances. Thus Mr. Hunsaker, speaking at the opening of the Goodyear Research Laboratory, gave a picture of war research which will be as valuable to air transport as the more practical lessons of actual operation. The present trend is to use engine cylinders of no greater volume than those available today, where ratio of volume to surface is favorable to cooling. But war experimentation indicates that engines of 24 or even 36 cylinders, and horsepowers of over 3000, are entirely practicable. Both in this country and abroad the combustion gas turbine has been successfully used on land, and we are using a large number of exhaust-driven turbo-superchargers. It now appears that we have alloys which can withstand the excessive temperatures and high speed of the gas turbine. And, if the gas turbine for airplane use should come, it will remove many troubles inherent in the conventional engine such as cooling difficulties, detonation, vibration, and the like. The gas turbine may, however, have poor fuel economy. Propellers can scarcely be improved in efficiency, but, by using counter-rotating propellers, a way will be found to absorb the immense power of any engine. In aerodynamics, the laminar flow wing and the complete enclosure of the power plant will give better performance. These and other achievements of laboratory and experimental factory will coordinate with the advances made by actual experience in giving us greatly improved transport airplanes.

Because stress is placed on advances to come, there is no reason to assume that our present equipment is faulty. On the contrary, we already have splendid transport planes. The Douglas DC-3, almost universally used in commercial operation, is a magnificent ship, as thousands of travelers can testify, even if it is certain to be displaced by



The Curtiss Caravan, built almost entirely of wood



Lockheed's Constellation, faster than any transport built to date

better ships in the future. We have only to turn to the pages of our daily papers to see what the four-engined Douglas C-54 Skymaster and the twin-engined Curtiss C-46 Commando are doing so efficiently the world over. They are carrying troops, parachutists, technicians, jeeps, howitzers, supplies, ambulances, engines, spare parts, to our Armies and are pointing the way to greater post-war mastery of passenger and cargo carrying by air. Space will not permit us to deal specifically with all the fine aircraft used in this service; we can only speak of two machines actually produced since the beginning of the War.

One of these, the Curtiss (C-76) Caravan, flown for the first time more than a year after our entry into the War, is noteworthy for two reasons. It is a real air freighter and is built almost entirely of wood and plywood. The Caravan has a wing spread of 108 feet, is 68 feet long, and is powered with two engines of 1200 horsepower each. It is a "high-wing" design, with the fuselage floor near the ground, a level floor because of the tricycle landing gear, and a loading door opening up at the very nose. Thus it embodies some of the basic elements of the cargo airplane which we shall see on many post-war craft. Its construction embodies molded plywood, laminates, and plain lumber. For the moment there is sought the saving of strategic materials and labor, but plywood and plastics may be here to stay in the airliners of tomorrow.

The Caravan has relatively low wing loading, relatively low power for size, and only moderate speed, but it is a freighter. The other war-time achievement to be considered is the Lockheed Constellation, which lies at the other end of the scale; it has heavy wing loading, tremendous power, and a speed considerably higher than that of any transport built to date. And the high speed is combined with long range and large carrying capacity.

Exact specifications of the Constellation cannot be given, but here are some reasonably accurate and striking facts. The Constellation will cross the continent, non-stop, in less than nine hours and fly to Honolulu in twelve. It can carry 55 passengers and a crew of nine, non-stop from Los Angeles to New York in record time. It is powered by four 2000-horsepower Wright Cyclone engines and can reach 16,500 feet with two engines dead. The cabin is supercharged so that an air density of 8000 feet can be maintained while the plane is actually flying at 20,000 to 35,000 feet. The almost circular cross-section of the fuselage facilitates the pressurization. Three large vertical tail surfaces help to give control and stability. Again we see the tricycle landing gear. Built for TWA, the Constellation has been taken over by the Army because of its troop- and supply-carrying potentialities.

Not only shall we have vastly improved transports in the future, but a greater variety of aircraft as well. There will be helicopters for ferrying to the airport and for other auxiliary services. Small planes will serve small communities, possibly with the aid of the cargo pick-up system. The Douglas

The Constellation just after take-off, showing landing gear

DC-3 will yield its proud position and become a feeder airplane. There will be planes exclusively devoted to cargo, of moderate speed; feeder line planes; huge, fast, passenger-carrying ships for non-stop operations of over 1000 miles. Announcements have appeared in the press of great six-engined giants of over 200,000 pounds gross weight being built or to be built by Glenn Martin, Harry J. Kaiser, Higgins, and Howard Hughes. Tom Girdler, of Republic Steel, now associated with Consolidated, has stated that his engineers can build a 500-passenger plane that will fly at something like 400 miles an hour.

In these columns is presented a table of the characteristics of airplanes to come, drawn from the paper by Mr. Davies; these are less ambitious than the giants just mentioned, but are more likely to be realized soon. From this table we can draw a number of interesting deductions. The biggest airplane for long-range domestic use should carry 100 passengers in day-time service, and be equipped with a total of 12,000 horsepower. For shorter range a 75-passenger plane is likely to be sufficient. Both types will cruise at over 260 miles an hour, and both will have very high wing loadings, with the extraordinary figure of 75 pounds per square foot for the larger craft. The ship listed as No. III will have a freight load of only 14,100 pounds, indicating that Mr. Davies, an experienced airline engineer, does not immediately expect huge cargo loads. But even type IV, the feeder line plane, will be bigger than the DC-3, a sign that transports will constantly grow larger. The small cargo

AIRPLANES TO COME, AS PREDICTED BY W. W. DAVIES

Type	Airplane I Low-Wing-Mono.	Airplane II Low-Wing-Mono.	Airplane III High-Wing-Mono.	Airplane IV High-Wing-Mono.
Takeoff Weight—(Lbs)	128,500	80,000	43,000	32,500
Landing Weight—(Lbs)	110,008	70,000	40,000	30,000
Weight Empty—(Lbs)	76,770	46,405	24,925	19,050
Useful Load/Gross Wgt.	40%	42%	42%	41%
Wing Loading (Lbs/Sq. Ft.)	75.0	57.0	32.3	32.8
Power Loading (Lbs/HP)	10.5	9.3	12.7	13.0
Number Engines	4	4	2	2
BHP/Eng.—Max.—(BHP)	3000	2150	1700	1500
Cruise Speed—(MPH)	266	260	212	210
Range—Max. (Mi.)	2500	1200	750	1300
Span—(Ft.)	141	118	115	100
Length—(Ft.)	118	97	73	69
Number Passengers				
Day—Max.	100	75	52	None
Night—Max.	56			
Mail or Cargo—Max. (Lb)	4500	3000	14,100	10,410
Type Gear	Tri.	Tri.	Tri.	Tri.
Cabin Superch'g.	Yes	Yes	None	Cockpit and some compartments

or combined cargo and passenger ships will be much slower, with cruising speeds of only 210 miles, and will have lighter wing loadings because they will make use of smaller fields. For passenger ships, the low-wing position is the more attractive because the wing then gives most protection. For cargo planes the high-wing position may work out best because the fuselage is then near the ground for loading and there are no wings to impede the approach of motor trucks.

Mr. Froesch also feels that a 50 to 60 passenger capacity in domestic operation is a practical limit. Beyond a certain size, the utilization factor drops. Power plant installations, he thinks, will be self-contained and interchangeable. Landing gears will be simplified. Since friction brakes on the wheels will no longer be satisfactory on very large planes, aerodynamic braking will be achieved by reversing propellers. To avoid wear of tires, they will be prerotated before landing. Cockpits will be much better lighted, windshields made proof against impact of birds. Fire protection will be much better. Gas tanks will be built in. Pressurization of the cabin will be frequent.

Immediately after the war we can expect a transitional period of some uncertainty. While special transports will certainly be built, there will be a great temptation to utilize war equipment, with some disappointments in regard to accommodations and safety. Airlines will buy cargo planes but not accept cargo-carrying with complete conviction. But eventually the higher speeds and lower direct flying costs of the most modern equipment will fully justify themselves, and the important postwar transport will bring to the airlines a vast amount of traffic—passenger, mail, and cargo—in quantities which it is difficult to overestimate.

⊕ ⊕ ⊕

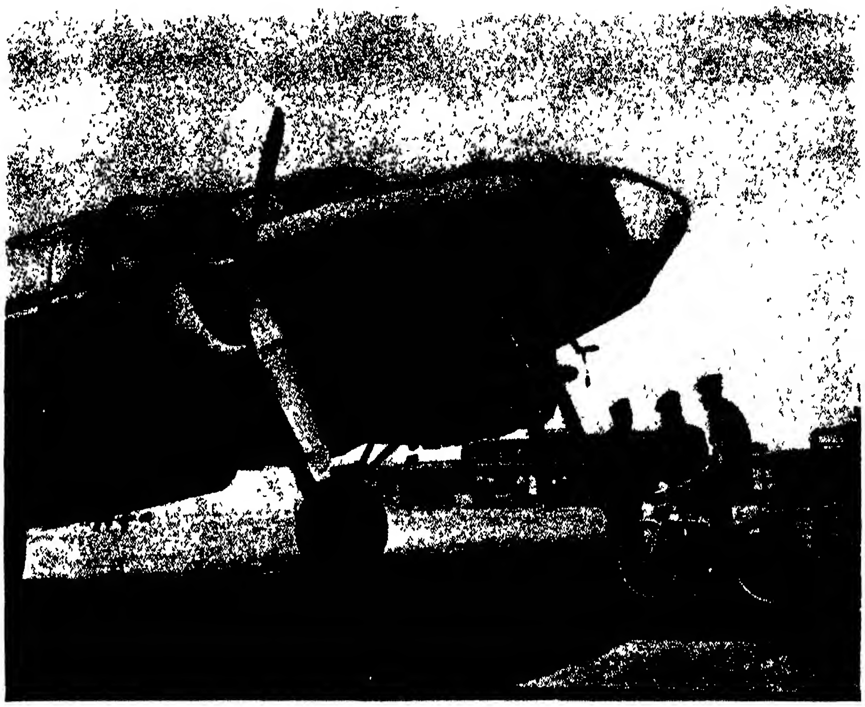
A FLYING SCHOOLHOUSE

Provides Systematic Instruction for Heavy Bomber Students

The war has done much to speed up the training of airplane pilots: The Link Trainer and other devices provide the sensation of flying and teach the student how to counteract the effects of gusts without leaving the ground; other devices teach him aerial gunnery and bring home the mistakes he makes in fictitious combats. These devices involve air-driven bellows to provide motion; moving pictures to simulate the horizon, to portray the enemy, and to enable accuracy of fire to be studied.

Another example of these modern instruction methods now appears in the four-engined Boeing bomber, affectionately known as Bessie, which has been arranged as a species of flying schoolhouse. The craft is identical with the Flying Fortresses operating so successfully in many parts of the world, except that its armament has been removed and its fixtures renovated to provide room for classes.

A regular crew of instructors is in charge of the training program and the



Bessie, the flying schoolhouse for heavy bomber students

Schoolhouse flies to various centers. At these centers, advanced heavy bomber students receive systematic instruction. They learn how to secure the highest possible operating efficiency and maximum flight range, by co-ordinating a multiplicity of factors such as fuel mixture, air speed, turbo-supercharger pressure, engine speed, and altitude. The students also learn how to act in difficult circumstances as when, for example, one or more of the engines is crippled in the course of a bombing mission.

The flying classroom, organized by Boeing Aircraft, was originated by Eddie Allen, the famous engineer and pilot who recently perished in a test flight, and is another reason why his memory is so revered in aviation circles.

LATIN-AMERICAN AIRWAYS

Details of the Recent and Continuing Struggle are Available in Book Form

One of those rare men whose lives are devoted to public service without thought of financial or political advancement is William A. M. Burden, Special Aviation Assistant to the Secretary of Commerce. Fortunately for American aviation, it is in this field that lie Mr. Burden's vocation and avocation. To the writing of his recently published book, "The Struggle for Airways in Latin America," he has brought well-rounded knowledge and broad experience, which include the writing of a special report for the Coordinator of Inter-American Affairs.

To most of us, aviation in South America means Pan-American Airways; we can scarcely imagine how powerful the Nazis had become in South American aviation, how closely they had come to dominating our Latin neighbors with a fifth column of the air. Between 1920 and 1939 the German and Italian interests, with strong government backing, acquired control of 10,000 miles of air routes in South America, and established strategic airlines linking South America with Europe.

At the opening of World War II, the Germans, in spite of the blockade, expanded their aviation efforts still more. Yet, in the space of one year, our Government and our airways, acting in concert with the South American republics, succeeded in grounding every German and Italian plane.

Mr. Burden begins his book with a fine chapter, geographic and economic, on Latin America, and then describes the period of development when our companies, Pan-American and Pan-American Grace, entered the field and fought their way ahead with postal revenues as their only governmental aid. By 1932 Pan American had established itself splendidly. The keenest period of rivalry came between 1935 and 1939 when the German-owned Condor lines expanded to Argentina and Chile. The story of how the Axis efforts were counteracted, how their services gradually disappeared, and how American airways replaced them, is told quietly and effectively. We can well feel relieved that the task was done well.

But Mr. Burden does not limit his work to episodes. Statistics, charts, and economic analyses make his work scholarly as well as fascinating. Later he discusses potentialities of South America in the air, post-war policies in the air, and maintenance of friendly relations with our South American neighbors, as well as the sound development of our flying operations to the Southern Hemisphere. Possibilities of traffic and national and international legislation are well covered. The photographs are fascinating and include such striking pictures as the catapulting of the Dornier-Wal mail plane from the *Westfalen* and flights over the Andes.

Conducted by EDWIN LAIRD CADY

Taking Dust Out of Industry

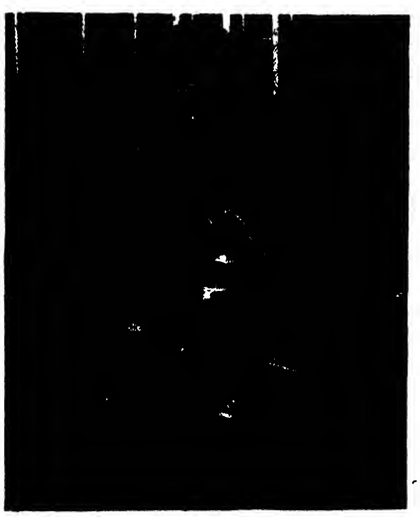
Originating Without as Well as Within the Plant, Industrial Dusts Represent Hazards to Production Processes and to Personnel Alike. These Dusts Present Problems that Science Has Answered in Many Ways, Depending on the Individual Factors Involved

DEALING with modern high-speed factories is a corps of dust-controlling technicians whose work grows in industrial importance every day, for dust particles, the tiniest enemies of factories, cause some of the biggest production troubles.

The range of those troubles is amazing: Fine instruments caused to give false readings, light or transparent plastics discolored, lubricants fouled, occupational diseases instigated and promoted, cylinder walls of Diesel engines and air compressors eroded or cracked, short circuits or fires caused in electrical equipment, explosions propagated, and plant "housekeeping" expenses increased—to mention only a few dust troubles.

Dusts may originate within a plant or come from outside. And of the two, the outside dusts are the harder to control, for no one can predict what may be in them.

The managers of one machine shop found that workers in the office as well as the shop were suffering with headaches, asthma, and allergic skin troubles Dust was one of the causes suspected, but the shop was producing no dust that could have such effects. Slides placed on the office walls over night were used as detectives to find out what went on. In the morning they were found coated with fine flour dust from a nearby cereal plant. The culprit causing the illness was smut and grain rust evacuated from the "cyclone" on the grain mill roof. Strange to say, the workers in the mill itself were pretty well protected, but the cyclone exhaust going down wind was dangerous to a whole neighborhood.



Charging wires and discharge plates of an electrostatic-type air cleaner

Fine dust travels farther than coarse dust; in a 10 mile per hour breeze, fly ash of five-microns size (a micron is one twenty-five thousandth of an inch) discharged from a stack 300 feet high can travel 276 miles before sinking to the ground, while a 60-micron size would travel two miles. The importance of this is that the finer the dust the greater the damage to human lungs, especially if the dust can cause silicosis.

First thought is given to doors and windows. It is impossible to seal these so tightly that dust could not get through. The answer is "plus pressure ventilation"—keeping the air pressure within the room slightly higher than that outside, so that any air leakage will be outward and will blow the dust away.

Some dust will get in anyway, for wind pressure outside the walls can at times become greater than ventilation pressure within. Furthermore, the most efficient ventilating air cleaner known—the electrical "Precipitron"—will not take more than 95 percent of the finest particles out of the incoming ventilation air. Then as much as possible of the dust which escapes all precautions can be trapped by keeping walls and floors just tacky enough so that any dust which strikes them will stay on them. So little dust actually does get in that walls look freshly painted although unwashed for four years after last being decorated, but even this little can do damage; the very finest industrial equipment is kept in specially sealed rooms which still are far from completely dust proof.

The Precipitron is the greatest boon ever given to the dust-control engineer. Before this device came on the market, water sprays were the best air cleaners, but it is impossible to design a spray that will get all of the dust—even air bubbled up through clear water will contain dust within the bubbles. The Precipitron works on an electrostatic principle. Air going through this device flows past wires containing an electrical potential of about 12,000 volts. Dust particles of all sizes, from extremely coarse to the finest that any magnifying glass can make visible, are given positive electrical charges, the charging taking about one hundreth of a second. The air then passes into a collector section containing plates which carry a negative charge of 5000 volts. Since opposite polarities attract, the dust particles are drawn into the field of these plates and out of the air. The cleaned air then passes on to its point of use.

Not all dust control requires as thorough a job as the Precipitron will do. In a steel mill, for example, Precipitrons are used to clean the cooling air which is fed to large motors; for even a little dust in these machines could cause fires or do other expensive damage. But ordinary filtering or water spraying will do a good enough air-cleaning job for the plant in general.

An ideal mill is plotted out into areas for dust control as carefully as for materials handling or for fire control. Needs of each area vary on a scale by which dust concentrations are called hazardous, nuisance, tolerable, or free.

Materials used for some polishing operations produce dusts which might cause silicosis. Following the formula commonly used in mines, any concentration of such dusts which adds up to over 5,000,000 particles per cubic foot of air is in the hazardous class and must be reduced. It is possible to take out more than 98 percent of the weight of dust in the air, and still have a count that is more than twice too high, since the removal of just a few heavy particles will reduce the weight while leaving the count of fine particles almost undisturbed.

A shot-cleaning machine is sealed dust tight and a cyclone removes the dust as fast as it is produced

Talc polishing compounds can be allowed 10,000,000 particles per cubic foot of air without being hazardous, but the talc has a way of penetrating everywhere, making "housekeeping" problems hard. Therefore, any concentration over the 10,000,000 figure is called "nuisance"—the men hate to work in it anyway—and is reduced.

Concentrations which are neither nuisance nor hazardous are within the tolerance threshold. But the company likes to go still further and reach the

"free" point; this latter being subject to no exact definition but covered by the general description that any room is dust free when dusts do not make their presence felt if cleaning of the walls is neglected for a three-week period.

First step in control of dusts originating within the plant is like that which is common to all industry. It is to eliminate each dust at its source. And the first move is to collect the dust as fast as it is produced.

Easiest way to collect dust at the source is to put shrouds, hoods, or complete enclosures over the dust producers and continually evacuate the dust through air suction. This often pays profits. The dust itself may contain valuable brass, copper, aluminum—even the nuisance fly ash from burning pulverized coal is valued as a fine polishing agent. Heat, too, is saved; the heat may be that originally put into the air by the plant heating system, or may be produced by the friction of grinding and other operations, but with outdoor weather averaging around 35 degrees and the indoor temperature 65 degrees, from three to nine tons of coal can be saved per heating season for each 1000 cubic feet of air capacity of the system which picks up the dusty air, cleans, and recirculates it.

Collecting the air at the dust source is, however, never completely effective, but every practical bit of ingenuity is used to increase this effectiveness. Nevertheless, there is a limit to the speed at which air can be permitted to enter the evacuator without the suction or draft becoming a nuisance in its own right, and that speed is not always high enough to keep the dust under control.

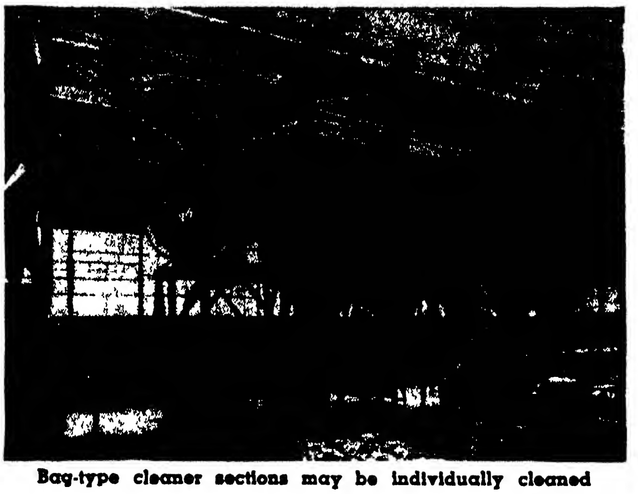
Second step in control is to clean the air of the room itself. This calls for collection ducts, or similar means, leading the fouled air to water sprays, Precipitrons, or other highly effective cleaners. Cleaning is accompanied by control of humidity and temperature—cleanliness, humidity, and temperature being the three main points of air conditioning.

With general air cleaning or air conditioning in use, the control of dust at its source is easier. The air evacuated at the machines is led through ducts to filters, or in some cases through settling chambers, cyclones, baffle type cleaners, and other steps before the filters, and then recirculated in the room.

Filters or high-efficiency cyclones, which will remove 98 percent of dusts by weight, are quite common. They leave the finer particles still entrained in the air, and keeping these down is the function of the more effective cleaners in the air-conditioning systems.

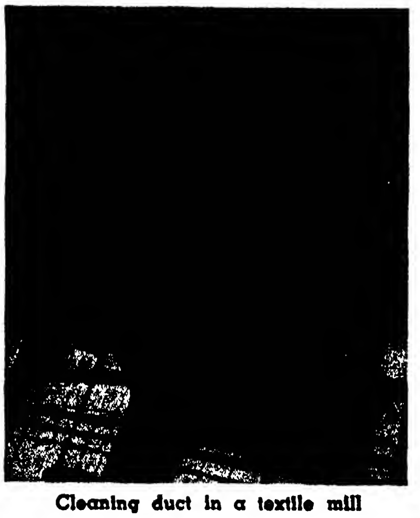
Dust loads on air-conditioning systems are kept down by isolating the worst dust-producing processes in special buildings or rooms. Controlling the dusts from these rooms, and sometimes classifying and saving them as valuable by-products or as materials to be returned to the production line, almost always calls for sequences of dust-removing devices.

First device in line may be a settling chamber. The effectiveness of such a chamber depends upon the sizes of the particles and their specific gravity. The larger the size and the higher the specific gravity, the faster the particles will settle out of the air and the higher


Bag-type cleaner sections may be individually cleaned

the velocity with which the air may be permitted to move through the chamber, or the shorter may be the distance the air travels in the chamber and consequently the less the floor space occupied by the chamber. A common device is a chamber having a sealed collector trough at the bottom; at regular intervals this trough seals itself off from the chamber so that no fouled air can escape through it, and automatically discharges to a conveyor which returns the collected dusts to the production line. Operation of such a collector may be manual, but often is fully automatic, being controlled by a scale which weighs the collected dusts and actuates a switch which turns on the necessary motors when enough dust has been collected to be handled as a controlled unit of raw materials.

Next in line after the collector chamber may be a low efficiency cyclone. This shares with the collector chamber the advantages of being extremely low in power costs for moving air through it, low in maintenance also, as the air movement is too slow to cause the dusts to do much abrading of its parts, and high in ability to cool off hot dusts whether or not the heat units from them are conserved for plant or process temperature control.


Cleaning duct in a textile mill

A baffle type cleaner may come after the low efficiency cyclone, or even take its place. In a baffle cleaner the air is caused to take abrupt changes of direction. As the air whirls around the corners between the baffles, centrifugal force causes some dust particles to fly out; dead air pockets also form to let dust settle out. Usually the dust is permitted to fall into collector sections, but in some cases the baffle surfaces are covered with oil or other tacky material which will hold dust that strikes them, and are washed and reoiled as often as necessary.

The drop in air pressure between the intake and the exhaust sides of a baffle cleaner is an index of the amount of adhering dust which is blocking the passages, and therefore of the need to rap or clean the baffles. This drop is easily measured with a water column, the column being a U-shaped tube with one end open to the intake and the other to the exhaust and partly filled with water. The water will be pushed down at the side of higher pressure and will rise correspondingly at the lower pressure end, the amount of rise being an index of the pressure difference—a principle very old in the measuring of stock drafts.

The water column also is commonly used as an index of the need to clean a filter. Many types of filters use dust itself as part of the filter medium; the dirtier the glass fiber or cellulose bats, the finer the dusts which will fail to pass through them. Presuming a filter to be next in line after the cyclone or the baffle cleaner, good management may call for letting the air which reaches the filter be dusty enough so that the filter will retain its effectiveness over long time periods but not so dusty that the filter overloads. The dirtier the filter the greater the pressure drop of air passing through it. The water column measures this drop and tells when the filter is not dirty enough to be at its best or is so dirty that, if a dry type, the bags or bats must be replaced; or, if a wet type, they must be cleaned and re-oiled.

A water column also indicates when the bag type filter needs shaking or rapping, and can indicate the presence of torn bags. This type of filter often is built in sections with many cloth or asbestos bags per section—cotton bags usually being used for air temperatures up to 170 degrees, Fahrenheit, wool up to 220 degrees, Fahrenheit, and asbestos to 450 degrees, Fahrenheit. Individual sections can be shut off for dumping or rapping to clean the bags, the sections being ready for further service when cleaned. When dusts are to be returned to the production line, the bags often dump directly into conveyor sections

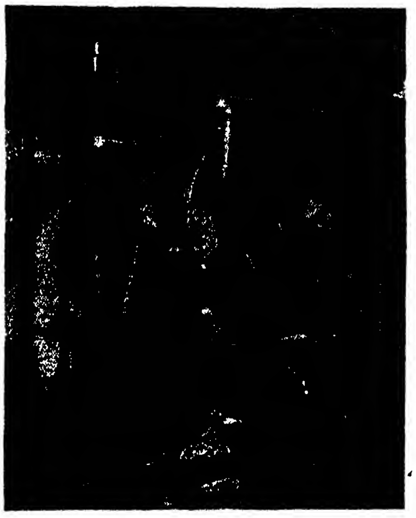
which are sealed so that the dust in them can travel only to closed containers or process equipment.

High-efficiency cyclones may be used immediately ahead of filters or, by taking out over 95 percent of the weight of dusts, may do such a good job in their own right that no filters are necessary. They differ from low-efficiency cyclones in that they are smaller in diameter and the air in them whirls at much higher velocity, producing greater centrifugal force, and therefore they take out much more of the dust. High efficiency cyclones are likely to have features which add greatly to their effectiveness while reducing maintenance costs.

Last link in a chain of air cleaners may be a water spray or a Precipitron, or both. The spray aids humidity control, the Precipitron does a more thorough cleaning job; selection is by conditions to be met.

Important wrinkle in dust control is elimination of dust producing processes. In one large foundry, the sand coated surfaces of castings had been cleaned by silica sand blasting, setting up a silicosis hazardous condition any time the sand blast machine leaked. Steel shot substituted for the blast sand greatly reduced the problem. A wet cleaning process eliminated the hazard that even the steel shot had left.

With air conditioning so improved, portable air cleaners are being used to take care of casual or temporary problems. The sand blasting of a masonry surface can set up short-lived but dangerous silicosis hazards. Removing of old paint, or welding of machine parts which had been painted, can create fumes and dusts containing dangerous quantities of lead and even of mer-



A cyclone is installed directly at these grinders to collect the dust

cury. Production machines which can temporarily increase their dusts production need temporary amplification of the evacuation through their hoods.

An enemy as elusive as dust needs auxiliary reinforcements as well as regularly established equipment for ideal control.

OIL TEMPERATURE

Must be Controlled for Highest Efficiency in Machinery

Modern bearings must have exactly the right quantities of lubricant at exactly the right pressures. Let the temperature of the oil in the lubricating system change, and either the oil will become lower in viscosity, leading to more oil being fed at the same pressure, or the same amount of oil will be fed at lower pressure, or if the viscosity becomes higher, then pressure will stay the same but less oil will be fed. In any case the shape and position of the oil wedge in the bearing will be changed, the ability of the oil to scavenge will vary, and the accuracy of the machine as well as the life of the bearing will be reduced.

When cutting oils are controlled in temperature, parts on which they work are kept more accurate and in better alinement, which means more accurate production from the machine and longer life for the tools. Machines need shorter warm-up periods too, for the controlled temperature of the oil brings the work areas to uniform operating temperatures far more quickly than if the heat of operation had to warm up the oil to its ideal working temperature.

In the cleaning of cutting oils, temperature control plays an important part. Hot oils give up their foreign matter in centrifugal type cleaning equipment more readily than cool oils, but some types of foreign matter may settle out of cool oils better than hot. And oils need to be clean if they are to keep tools at their best.

Heat is taken from oil by passing the oil through heat exchangers, sometimes by using large volumes of oil so the oil gets plently of time to cool between passes through the machines, and even by running it through mechanically refrigerated chambers. Often it is economical to flow the oil to a central point where both cleanliness and temperature can be fixed, but the practice of having oil temperature controlling refrigerators or other devices attached to individual machines is a growing one.

GRIND OR NOT

New Figures Aid an Old Argument

Differences of methods in the machine shop are largely matters of philosophy, with endless arguments occurring between engineers accordingly. And one of the moot points is whether to obtain fine finishes by machining slowly but nicely, or by hogging the stuff out and then grinding it smooth.

Opinions on this point have bounced all over the machine-tool marts. But the war has given one solid starting point with which to settle old arguments and start new ones. It is that when turning out 20mm anti-aircraft shells on automatic screw machines, grinding can be avoided if the feed is .002 inch per revolution but will be necessary if the feed is .004 inch per revolution, the cutting speed being about 120 surface feet per minute in both cases.

This bit of knowledge still leaves the boys free to argue as to whether it is better to cut twice as much per revolution and then grind, or to get the whole job over with on one machine, but at least they can add some figures to their epithets.

SPOT WELDING

Demands Clean Surfaces for Uniform Results

Spot welding of aluminum is an art which has grown up from its infancy during the war, but which will long survive the war; spot welding can produce not only sound welds, but consistent ones as well in this "hard to weld" material.

Any spot welding depends for success mainly upon uniformity of electrical resistance of the material to be welded, and the more difficult the welding the more the importance of this quality. Given uniformity of resistance, then such factors as the density of the current, the time period over which the current is applied, the pressure or mechanical shock used, the temperatures of the electrodes, and so on, all can be kept uniform for uniform results.

Aluminum alloy sheets have varied resistance at the points where they are pressed together for welding, due largely to the presence of foreign materials on their surfaces, or to the "chemical" surface effects of contaminants found in the air or in materials to which they have been exposed. One effect of this resistance can be to make the sheets weld more readily to the copper electrodes of the welding machine than to each other.

Cleaning the sheets to get uniformly resistant surfaces involves two problems. The first is that of getting off the foreign matter or soil which may be clinging to them, and the second is to take off the surface layer of aluminum oxide or other "chemical contamination" and expose the clean metal beneath. Thus a uniform resistance is obtained because contact is between uniformly clean parts.

The foreign matter is removed by alkaline cleaners, by petroleum solvents, by vapor degreasing, or by combinations of these methods. A thorough rinse follows; the surface must be "chemically clean" or show no break in the film of water clinging to it after immersion in water.

Modern method of removing the aluminum oxide coating is to immerse the sheet in an acidic cleaner of about 0.5 to 2.0 pH. The cleaners are specially made, and are mixed with water in proportions of four to six ounces per gallon.

Conducted by JAMES M. CROWE

Progress In Proteins

As the Chemists in their Laboratories Learn More and More About the Fundamental Chemistry of Proteins, Industry in the Factory Should be Able to Shift From its Present Fortuitous, Cut-and-Try Methods Toward New Progress and, in Turn, New Industries

VITAL to the life of all living cells, protein is also basic to a number of man-made products, some new, some old, but all of importance to the industrial world.

Protoplasm, the essential constituent of all plant and animal cells, consists mainly of water and the complex organic compounds of nitrogen which are called proteins. Since it has been shown that all protein is not chemically identical, however, the plural form of the word, proteins, is used to designate the closely related but different essentials of plant and animal life From these same groups are now made such prosaic and utilitarian products as buttons and fabrics, glues and paints, and a host of others.

In order to appreciate more fully some of the problems involved in the industrialization of proteins, it is needful to scan briefly what little—and it is little, indeed—has been uncovered by research into the fundamental nature of the proteins.

Animal life is dependent either directly or indirectly on plants for their supply of protein. Plants are able to synthesize or manufacture proteins from simple inorganic nitrogenous substances or in some cases by the utilization of atmospheric nitrogen. Animal organisms are not able to do this and must receive the necessary protein prefabricated in the diet. This does not mean that synthesis of proteins is impossible in animal bodies. Yet the compounds from which animals can manufacture proteins are in themselves complex nitrogenous organic substances—again, proteins.

Courtesy National Dairy Products Corp.
A spinneret through which viscous casein is being converted into fiber

In spite of the great importance and abundance of proteins in both plant and animal life, their chemistry is still largely obscure. One of the main difficulties in the field of research in proteins is the baffling complexity of their molecular structures. Of all the types of molecules found in nature, proteins are undoubtedly the most varied, complex, and largest. In fact, there has never so far been produced any specific and detailed proof of the exact structure of any protein compound.

In recent years there has been a revival of interest in the proteins. Their chemical nature has been vigorously attacked with new scientific tools, principally the X-ray, the ultra-centrifuge, and the electron microscope. Much progress has been made but there is still a long, long way to go.

On the basis of present theories, speculation as to the molecular architecture of proteins is fascinating but theories must still stand the test of experimental evidence.

For many years it was believed that the isolation of a protein in the chemically pure state was nearly impossible. Recently, however, this situation has changed quite completely. The enzymes pepsin, trypsin, and urease, and the hormone, insulin, have all been isolated and appear to be proteins. One of the most recent and brightest chapters in this search for protein in its chemically pure state is the isolation of the virus of the tobacco mosaic disease. This virus is described as a crystalline protein. The significance of this discovery lies not only in the great advance in the understanding of protein structures but in the fact that it connects proteins with such diseases as measles, yellow fever, the common cold, and several other diseases of both plants and animals.

Although biochemical reactions rank highest in importance in the present-day field of protein chemistry, natural protein products have been used empirically for a long time without realization of the complexities of their chemistry. For example, silk, wool, hair, and leather are all essentially protein products. In the course of the years a great deal of practical knowledge was acquired about the processing and handling of these materials by cut-and-try methods and by accidental discoveries, without much insight into their structure or their chemistry. In more recent years protein products such as casein, gelatin, and albumen have been widely used in industry for paper coating, adhesives, molded buttons and buckles, water paints, plywood and furniture glues, insecticide sprays, wax emulsions, leather dressings, films, plastics, textiles, photographic films, duplication processes, and many other applications.

Outside of the naturally occuring protein fibers such as silk, wool, hair, and leather, probably no single protein has been studied and utilized as extensively as casein, the principal protein of the milk of all mammals. This might have been expected since this constituent of man's earliest food is easily separated in a more or less pure state. In fact, there is mention that early Hebrew texts advised the women to save milk curds for a certain time of the year when an itinerant painter visited the villages and concocted a paint from the milk curds and natural colors to paint the peoples' dwellings. Undoubtedly this was the earliest reference to our so-called cold water or casein paints. It is also said that the craftsmen of ancient China, Egypt, Rome, and Greece used casein glue in fine woodwork. Apparently the art was carried along in a small way by European wood-workers through the Middle Ages.

Four spinnerets producing Aralac fiber are concealed beneath the foamy mass in this spinning box

In spite of the lack of exact chemical knowledge, the manufacture of casein was started as a real industry in Switzerland and Germany in the early 1800s. Patents on casein sizes and glues began to appear in the United States about 1800, and casein was being used in increasing quantities for coating paper between 1880 and 1890. The need for a strong glue in the manufacture of military aircraft from wood in World War I aroused great interest in the manufacture of casein glues and led to a thriving industry, whose ramifications are now manifold. On one side we have the field of plastics and artificial textiles, and on the other those applications more or less linked with the

desirable adhesive properties of casein.

With the increased demand for casein protein in industry, the first crude manufacturing operations were improved to the point where we now have efficient modern processes, which produce large tonnages of high-grade products.

Most casein is obtained from skim milk by precipitation of a protein brought about by the direct addition of hydrochloric or sulfuric acid, or by self-souring as a result of formation of lactic acid by fermentation of the lactose in the milk.

Another method employs rennet for the precipitation of casein. In either process, after the protein is precipitated the whey is removed and the casein is washed with water, ground and dried, and appears as a dry, white, sweet-smelling powder.

THE ACID-PRECIPITATED casein is usually used for adhesive or coating applications, while the rennet casein is preferred for the production of plastics.

The use of casein in plastics can be traced back to the year 1897 when a printer in Hanover conceived the idea of producing a waterproof coating on cardboard. As a result of his collaboration with a chemist who was working on the problem of waterproofing casein, the formaldehyde-casein reaction, on which a great deal of the casein plastics industry is built, was discovered This reaction was soon used to produce solid plastic masses, and commercial production of casein plastics was started by the Golalith Company of Harbourg. This name, "Golalith" which means "milk-stone" has since been used as a general term for casein plastics

In spite of a good start, casein plastics have made slow progress in America. One of the main reasons for this is that they are hygroscopic; that is, they absorb water, and this in turn deforms them. Certain other qualities do, however, make casein plastics desirable for small products such as buttons, buckles, beads, and other novelties, and they have enjoyed moderate success in filling these needs.

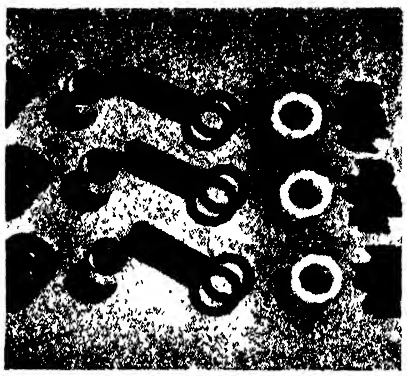
One of the best features of casein plastics is their affinity for a wide range of colors, affording various multi-color effects. Splendid pastel shades and streaked and mottled effects may be obtained that rival the beautiful natural effects of horn, jade, pearl, and so on.

Finished fluffy Aralac fiber ready to be pressed into 450-pound bales

One of the newer uses of casein is in the manufacture of synthetic textile fibers. Before the war started it was reported that a casein fiber called Lanital was in commercial production in Italy. Since that time an American product called Aralac has been put on the market, and is said to have overcome the weakness and brittleness of earlier casein fibers.

Another large field of protein chemistry lies in the production of glues and gelatin from stockyard wastes. The material common to bone, tendons, and skin of animals has been found to be a protein called collagen. This is an insoluble substance consisting mostly of the white fibers of connective tissues.

When this collagen is hydrolyzed, gelatin is obtained. Ordinarily, gelatin is a nearly odorless, transparent amorphous substance, which swells to many times its original volume when immersed in water Various grades of gelatins and glues depend on the raw materials and processes selected for manufacture.

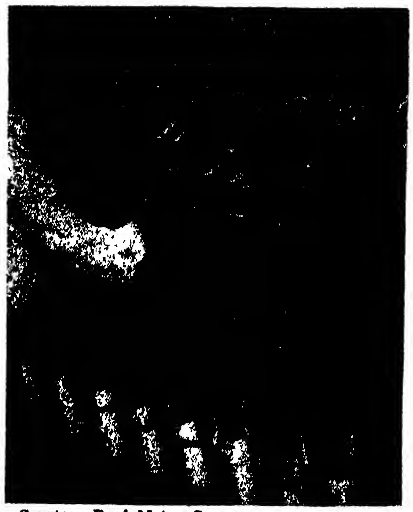


Courtesy "Modern Plastics"
Ornaments made from casein

Gelatin is used to a great extent in the food industry, in ice cream, marshmallows, desserts, and so on. In industry it is used as an adhesive, as a sizing for paper and textiles, in leather dressings, cold water paints, preparation of colloidal precipitates and emulsions, in matches, hectographs, printing, pharmacy, and photography. These are only a few of its applications to industrial processes. Yet the chemical structure of gelatin is still little understood.

Widespread attention is currently being paid to the soybean both as a farm product and as an industrial raw material. The soybean, while not definable as a protein, has a high protein content. Until the past few years the primary interest in the soybean was from a food standpoint, especially for animals and poultry. Also, the oil extracted from soybeans was soon found to have valuable industrial applications, mainly in the paint and varnish industry and to some extent in the soap industry. The principal use was as a component in the manufacture of butter and lard substitutes and as a salad oil.

It was soon found, however, that the large quantities of meal left from the solvent extraction of oil from soybeans could be considered an almost unlimited raw material for the production of soybean protein. If, for illustration, 10 percent of the 1941 crop of soybeans, estimated at 107 million bushels, was processed for protein, it would supply about a quarter of a billion pounds of protein.



Courtesy Ford Motor Company
Spinning soybean protein fiber

Soybean protein is a comparative new-comer to the industrial field of proteins It resembles casein more than any other protein and, in fact, in the early attempts to introduce it to industry it was called soybean casein, with the idea of trading on the good name of its already established brother protein. Indications are that soybean protein will find great use in many of the fields already pioneered by other commercial proteins.

RESEARCH work is being carried on both by government and industrial laboratories on the structure of protein molecules, and on the possibility of substitution or modification of their organic groups—possibilities which may result in appreciable changes both in physical and chemical properties. This work, which is being intensively directed toward a study of soybean protein, is expected to make this crop an increasingly important raw-material source for industry; as this source develops, the farmer will profit correspondingly.

Another protein extracted from a farm crop in large quantities is zein, obtained from corn. This is a fine, slightly yellow powder, which has been under investigation for a number of years by the companies manufacturing starch, with the idea of providing a raw material for plastics of the casein type.

Zein has the advantage over casein that the formaldehyde used for curing it can be incorporated directly into the plastic before forming, thus eliminating the lengthy step of curing in a formaldehyde bath which is necessary with a more highly reactive protein such as casein. The zein plastic is tough and has a transverse strength of about 15,000 pounds per square inch.

With zein, water resistance, which is

the weak point in many applications of casein plastics, is said to be better. The largest industrial use of zein, however, appears to be for coating papers, where it improves appearance and provides protection for the surface. Zein is outstanding in its resistance to penetration by greases or oils, and therefore may have a large potential use for making food containers and wrappings, where this property is of importance.

Within the past few months a new field for the production of proteins has opened up with the announcement of the Balls-Tucker processes for obtaining alcohol from wheat. In this process the protein is obtained as a by-product in a very pure state, and some observers say that the by-product protein may become more important than the production of alcohol. This would be a case of a new industrial tail wagging the alcoholic dog. Several food manufacturers, notably soup and bread makers, are considering the use of such proteins to fortify their products and round out their nutritive value.

Many of these recent developments in the production and commercial use of the newer proteins coincide with increased interest and research activity in the fundamental chemical nature of proteins. The work of all groups, including the significant discoveries of the biochemists, indicates a trend of accelerated progress into the secrets of one of nature's greatest and so-far darkest storehouses—one which is likely ultimately to yield new industrial fortunes.

⊕ ⊕ ⊕

FLUID CATALYSIS

Operates on a Principle of Industrial Importance

THE FLUID catalytic process which is now being employed to boost the supply of high-octane aviation gasoline represents a new chemical engineering technique which it is predicted will have many industrial applications not only in catalytic operations but also in many other non-catalytic processes outside the petroleum field.

The important operating advantage of the fluid catalytic process is its complete freedom from mechanical means for moving the catalyst or changing the flow of the cracking or regenerating streams.

The way in which this is accomplished is novel and noteworthy. The catalyst is used in a finely pulverized form, almost like talcum powder. This eliminates the requirement of forming the catalyst into lumps which can withstand, without deterioration, the alternating temperatures of the fixed bed type of operation as well as the abrasion of high-velocity gases. Special types of catalysts are thus available which otherwise would be impractical because of physical limitations.

The finely divided catalyst is not actually a "fluid." It is a powder maintained in a fluid, turbulent state, by passing through it at all times a certain minimum percentage of some vapor which may be either air, inert gas, steam, or petroleum vapor. The consistency of the catalyst thus handled might be compared to the sand just at the water's edge at the seashore which flows readily when supported in part by the water.

It is a remarkable fact that a properly pulverized solid mixed with even a small amount of such vapors attains an extraordinary degree of fluidity and can be handled exactly as if it were in fact a fluid. Thus in the fluid catalyst cracking plants the catalyst is circulated in a manner analogous to an airlift used to pump water out of a well, and the means used for this circulation is the petroleum vapor being cracked or the air used for regeneration or removal of coke from the catalyst.

Of particular significance is the fact that the fluid catalytic cracking process makes possible the use of types of catalysts and operating temperatures which would not be possible with other catalytic cracking processes. This permits greater control over the products produced in the cracking operation. These units can, therefore, be converted to work much more effectively in the production of materials from a given amount or type of crude available.

TARTRATES

Recovered from Wine Vats by New American Process

A YOUNG chemist in New York State's grape-growing Finger Lakes region has developed a new process that may help to ease the current difficult situation in the supply of tartaric acid and tartrates which are vitally needed in medicine, food, and industry. Two of these products are widely known as Rochelle salt and tartar emetic.

Consumers and suppliers of tartrates have been on tenterhooks ever since the war began, when supplies of these materials were cut off from the great wine-producing sections of France and Italy. Tartrates and wine go together, because the raw materials for the production of tartrates are formed on the sides and bottoms of vats and casks used in making wine. The crystalline crusts which form on the sides of the vats are known as argols and contain from 50 to 80 percent of potassium acid tartrate and 6 to 12 percent of calcium tartrate. The sediment in the bottom is known as wine lees and contains 20 to 35 percent of potassium acid tartrate and anywhere up to 20 percent of calcium tartrate.

Some refined tartrates are now coming in from Spain and Argentina, but not in sufficient quantities to ease the tight situation. The supply probably could be helped by relaxation of government import regulations which make the importation of argols and wine lees impossible.

Wineries all over the United States have therefore been striving to relieve the strain by recovering their argols and wine lees, a process which in ordinary times would not be economical. One of the obstacles encountered was the obstinacy with which the argols clung to the sides of the vats and casks. It often required one man four days with hammer and chisel and sometimes an electric drill to remove the deposits from one vat.

To speed up this recovery, a young chemist named Ralph Celmer, working with the Taylor Wine Company, developed a process for removing winestone which will do the job in four hours instead of four days. In his method the casks are filled with a one-half percent solution of sodium hydroxide, or caustic soda, at a temperature above 100 degrees, Fahrenheit. This solution removes the winestone, which is subsequently recovered and refined in further operations. In one case the winestone was removed from a 7000 gallon tank in four hours, representing a saving of about 92 man-hours.

Celmer, for his work, has been complimented by the War Production Board, and his process has been made available to other companies in the wine industry.

"WET-STRENGTH" PAPER

Now Commercially Practical for Many Purposes

A SHORT time ago it became necessary to ship potatoes to market in paper bags because of the need for conserving burlap and other packaging materials. When some of the farmers first heard of this idea they were skeptical and quite sure it wouldn't work. But they hadn't yet heard about "wet-strength" papers, whose commercial development and application had been accelerated by the use of a new process and the pressing demands of war.

The new bags soon demonstrated their worth. The result is that "wet-strength" papers are now being used not only for shipping vegetables whose moisture would cause bursting of ordinary paper, but also for wrapping meats and frozen foods and a number of other commodities for overseas shipment; for camouflage strips and nettings; for printing books and pamphlets used by the armed forces and subject to wetting in the field; and for maps, charts, and blueprint papers. It is even possible to make paper towels which can be used, rinsed, dried, and used again.

One of the latest processes in this development of paper having a high strength when wet consists of incorporating an acid solution of a synthetic resin, known as melamine, with the paper pulp in the beater before the sheet is made. The treated pulp is made into a sheet in the customary manner on regular paper-making machines without modification of either the machine or the method of operation. The colloidal resin particles, which have a positive electrical charge, attach themselves to the negatively charged cellulose fibers of the paper and form such a close bond that they cannot be washed free. It is this hold on the fibers that subsequently gives the paper its high strength and resistance to rubbing when wet.

Conducted by ALBERT G. INGALLS

THE PLASTICS industry as it is known today is considered to have started with the invention of Celluloid in 1869 by John Wesley Hyatt, an enterprising printer, who in later years also achieved roller-bearing fame. Celluloid, which is still being manufactured essentially as Hyatt developed it, is looked upon as the world's first synthetic organic plastic. In its development by the Celluloid Company, organized in 1872 in New Jersey, it began almost immediately to play an important role in the drama of industrial progress. Applications multiplied, from the popular collars and cuffs (kept constantly fresh by a damp cloth) to calendars, buttons, piano keys, knife blades, dice, dominoes, and dental plates. Over 25,000 uses have been found for Celluloid

Plastics' Parade

A Systematic Survey of the Growing Group of Synthetic Products Which Are Invading Almost Every Field of Industrial Endeavor. Their Wide Range of Physical and Chemical Characteristics Adapts them to Many Jobs as Substitutes, to Many Others as Original Materials

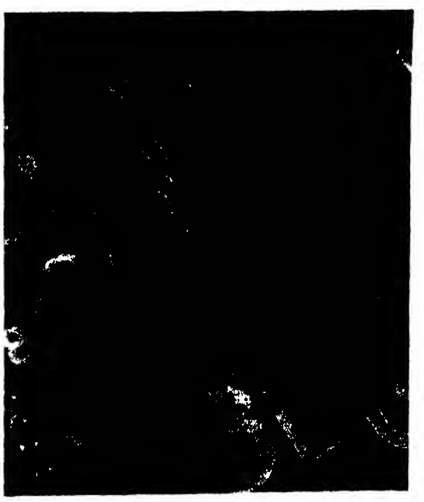
A. F. CAPRIO
Chief, Patent and Data
Celanese Corporation of America

Remarkable as this growth has been, the significance of the Celluloid invention has been much more far-reaching in scope, because of the immense stimulus it provided for research leading to improvements, particularly in studies to overcome the drawback of high flammability. Numerous attempts were made to retard the burning of Celluloid by the incorporation of fire-retarding agents which liberated water and smothering gases when heated. These, however, while effective for the purpose intended, introduced other undesirable properties.

The development many years ago, by the Celluloid Company, of the plasticizer tricresyl phosphate, now widely known in the trade as Lindol, marked another milestone of far-reaching importance. This non-flammable, odorless, colorless liquid of high boiling point and extremely low volatility found not only a use as a plasticizer in plastics and lacquers, but years later found extensive application as a valuable additive in extreme pressure lubricants and as an air-conditioning medium. More recently it has been in much demand in synthetic-rubber insulations and coatings, a field in which the war department is expediting full capacity production. In the last war, triphenyl phosphate, a homolog of tricresyl phosphate, found extensive use in the coating of airplane fabric wings to render them taut, waterproof, and flameproof.

Thus it is seen how invaluable have been the outgrowths of Celluloid, not to mention the discovery of amyl acetate in 1882 by John Henry Stevens, a co-worker of Hyatt, a discovery which paved the way for the modern lacquer industry. Celluloid research is also credited with the establishment of the highly important synthetic camphor industry in the United States.

The successful development of Celluloid also made possible the motion picture industry. In Newark, New Jersey, the Reverend Hannibal Goodwin was handicapped by the continual breaking of the glass stereopticon slides used to illustrate and popularize his religious lectures. He was aware of the development, at about 1890, by the Celluloid Company, of a continuous, clear flexible film He conceived the idea of substituting this unbreakable base for the fragile glass. Like Hyatt he went to work in his attic and, despite the annoying disturbances of occasional explosions, he finally succeeded in making and patenting a process of utilizing a spool of film for photographic purposes—the forerunner of the perfected motion picture film of the present.



Grommets, washers, and other forms for use on airplanes are cut or shaped from transparent plastics which are non-corrosive, light in weight, and water- and grease-proof

The flammability of Celluloid also stimulated research abroad. In 1890, Dr. Adolph Spittler, a teacher in Hamburg, Germany, tried to make a "white" blackboard substitute. He added acid to milk and then treated the coagulated mass with formaldehyde to harden it. This marked the discovery of casein plastics, although their manufacture did not begin until 1900, and the commercial development of the industry did not get under way in this country until 1919 when applications were found for buttons, buckles, and novelties. Casein, a protein substance from the animal kingdom, inspired research years later in vegetable protein products, such as soya bean, from which plastics can also be made.

In 1909 Dr. Leo Baekeland, a Belgian chemist, was looking for a substitute for the expensive shellac used in making varnishes and insulating materials. He succeeded in obtaining a hard substance by heating carbolic acid or phenol with a solution of formaldehyde gas in water. Phenol is a by-product of coal tar but it can be synthesized from benzene, C_6H_6. Formaldehyde, having the formula H_2CO, is synthesized from two other well-known gases, carbon monoxide and hydrogen. The new plastic was called Bakelite in honor of its inventor.

Unlike Celluloid, Bakelite is representative of the "thermosetting" type of plastic. It undergoes a chemical change when sufficient heat is applied, as in molding, and the final product is no longer fusible, but hard and set like cement; whereas Celluloid can be softened and remolded like wax or butter without suffering any chemical change. For this reason Celluloid is termed a true "thermoplastic" substance.

BAKELITE soon found application in the electrical field as an insulating material, but since then the uses have been multiplied a thousand fold. Other tar acids besides phenol, such as the cresylic acids, are used in making Bakelite today. Other aldehydes, such as furfural, have also yielded successful commercial products.

Some of the drawbacks of the Bakelite resin have been overcome with the development of cast phenolics in 1928, of which Catalin is an example. This resin is prepared in the form of a viscous syrup which is poured or "cast" into lead or rubber molds and hardened by heating.

Along with the hot molded phenolic plastics in 1909, a third plastic material, known as the cold-molded or bitumen type of plastic, appeared. The raw materials used here are asbestos, asphalts, coal tar, resins, oils, and so on. While considerable industrial importance was claimed during the first 15 years or so, competing with Bakelite, the production of cold-molded products has fallen off considerably because of the commercial appearance of other materials.

Shellac molding compositions were extensively exploited during the beginning of the century, particularly for making phonograph records. Today shellac of insect origin is restrict-

its use in comparison with the broader applications of synthetic resins.

Thus, up to 1925, five basic plastics had been developed; namely, Celluloid, shellac, cold-molded plastics, Bakelite, and casein plastics. Since 1925, the growth has been most remarkable. A new plastic appears almost yearly.

The first revolutionary change of this later-day growth came in 1927 with the appearance of Lumarith. Years earlier, Dr. Camille Dreyfus had developed the use of cellulose acetate non-flammable airplane fabric dopes, which contributed in a major way to the Allied victory in World War I. This cellulose ester is made by treating cotton linters with acetic acid, acetic anhydride, and a catalyst. Its use as a base for non-flammable film had been worked out in 1909, but the utilization in plastics had to await a more economical manufacturing process for making the material.

The Family

GROUP	NAMES	OUTSTANDING CHARACTERISTICS	TYPICAL USES
CELLULOSE DERIVATIVES			
Cellulose Nitrate	Celluloid, Pyralin, Nixonoid, Nitron	Thermoplasticity, unlimited color range, ease of fabrication, cementability, toughness, water resistance, flexibility, flammability.	Hammer heads, bag frames, fountain pens, index forms, piano keys, brushes, buckles, novelties and toys, shoe lace tips, spectacle frames, toilet seats, tool and cutlery handles, wood heel covers, pipe line wrappings, films and lacquers, mathematical instruments, tooth brush handles.
Cellulose Acetate	Lumarith, Plastacele, Tenite I, Fibestos, Nixonite	Thermoplasticity (injection, compression and extrusion molded), unlimited color range, ease of fabrication, cementability, high impact strength of molded objects, flexibility, slow burning.	Photographic films, packaging material, transparent rigid containers, airplane cockpit enclosures, automobile accessories, extruded strips, combs and toilet articles, electrical appliances and insulation, lamp shades, telephone bases, spectacle frames, hardware, watch crystals, fountain pens, gas-mask lenses, pressure-sensitive tape backing, nameplates, dopes and lacquers.
Cellulose Acetate Butyrate	Tenite II	Thermoplasticity, compatibility with many plasticizers and resins, low water absorption.	Automobile accessories, fishermen's equipment, spray nozzles, shower heads, gun stocks, gas mask parts, shoes.
Ethyl Cellulose	Ethocel, Lumarith ethyl cellulose, Hercules ethyl cellulose, Nixon ethyl cellulose	Thermoplasticity, compatibility with resins and plasticizers, flexibility and toughness at low temperatures, low flammability, water and alkali resistance, ease of fabrication.	Rubber-like articles, adhesives, cable and wire coatings, hot melt compositions, electrical insulation, trim moldings, ice trays and hose nozzles.
PHENOLICS			
Molded phenol-formaldehyde resins	Bakelite, Durez, Heresite, Durite, Indur, Makalot, Resinox, Textolite	Thermosetting, chemical inertness, heat resistance, water resistance, dimensional stability, limited color range.	Automobile and airplane parts, camera cases, closures, electrical insulation, handles, helmets, plywood laminations, housings, telephone equipment, shell caps and plugs, ammunition fuses, pumps, gears, paneling, abrasive disks.
Cast phenolic resins	Catalin, Marblette, Opalon, Prystal	Colorability, machinability, non-flammability, rigidity.	Costume jewelry, clock cases, radio housings, laminating varnishes, signs, kitchen utensils and handles, drawer pulls, instrument dials.

Another factor that contributed in a great measure to the success of cellulose acetate was the so-called injection molding process. In this method the cellulose acetate molding material is introduced into a heated cylinder and, when sufficiently heat-softened, it is forced by high pressure through a narrow orifice directly into a chilled mold or die. In a few seconds the die is opened and a number of the molded articles, such as combs, completely finished, are ejected. This combination of Lumarith and injection molding made possible many of the most spectacular results of modern plastics applications, since it meant rapid, economical cycle molding.

Before the advent of molding powder, cellulose acetate plastics had appeared in the form of sheets, rods, and tubes, as well as film manufactured according to the well-established Celluloid methods. Since that time great improvements have been made in simplifying the processing made possible by the greater stability of cellulose acetate under heat and its easy weldability compared with Celluloid.

Extrusion molding, in which the molten material is extruded in continuous lengths through a die opening, is also finding today extensive application for the manufacture of rods, tubes, strips in definite profiles.

In 1930 a transparent packaging material appeared on the market. The first of the rigid transparent materials, it revolutionized packaging in the thirties. This was followed by cellulose acetate foil for wrapping purposes.

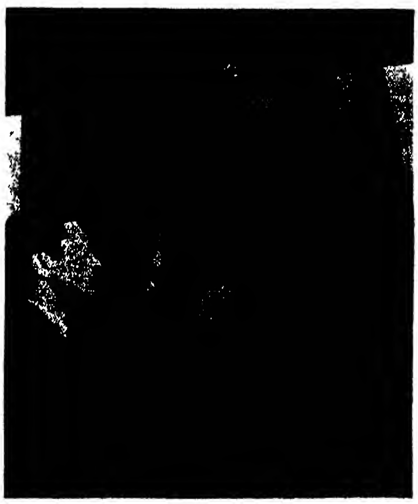
Besides cellulose acetate plastics, there appeared at about the same time the urea-formaldehyde plastics of which Beetleware is an example. This is another thermosetting plastic in which urea in place of phenol is reacted with formaldehyde. Urea is a compound of carbon, hydrogen, oxygen, and nitrogen and has the chemical formula $OC(NH_2)_2$. It can be made synthetically from carbon dioxide and ammonia, which in turn is produced from the nitrogen of the air.

The development of urea plastics permitted unlimited color possibilities in the thermosetting type of plastic. The melamine plastics are outgrowths of the development of various urea products.

In the thirties the vinyl ester resins also began to make their appearance under the trade name of Vinylite. Ethylene gas has the formula $CH_2{:}CH_2$. It is known as an unsaturated organic compound and is derived from petroleum. If one hydrogen atom is removed, the residue, $CH_2{:}CH$—, is known as the vinyl group. If this is joined to a chlorine atom the resulting compound is vinyl chloride. If the other hydrogen atom is removed and also replaced by another chlorine, the product is known as vinylidene chloride. If the vinyl group is attached to an "acetate" radical, the compound becomes vinyl acetate.

All these vinyl esters, of which there are a great number, exhibit the property of polymerization. In this the molecules of the same compound combine with each other to form complex, long-chain structures.

The polyvinyl esters, such as vinyl acetate and vinyl chloride, had been known many years before, but their commercial development was slow.



Glazing material which may be installed with a hammer is composed of a shatter-proof plastic and wire. It is also used where possibility of explosion makes glass dangerous

of Plastics

UREAS			
	Beetle, Plaskon, Uformite, Bakelite urea.	Unlimited pastel colors, absence of odor and taste, thermosetting, hardness, electrical insulation, light diffusion.	Closures, buttons, electrical insulation, tableware, plywood and veneer bonds, housings, baking enamels.
VINYLS			
Polyvinyl Acetate	Gelva, Vinylite A	Clarity, adhesiveness, absence of odor and taste, thermoplasticity, Colorability.	Adhesives, inks, molded articles, coatings.
Polyvinyl Chloride	Koroseal, Vinylite Q	Chemical resistance, water resistance, absence of odor and taste, toughness.	Cable coverings, coated fabrics, tank linings, gaskets.
Vinylidene Chloride	Saran, Velon	Thermoplasticity, high tensile strength, absence of odor and taste, non-flammability, resistance to water and chemicals, ease of machining.	Woven and braided fabrics, house screens, pump parts, pipe lines, couplings, gaskets, valves, battery cases.
Polyvinyl acetate-chloride copolymer	Vinylite V	Chemical resistance, colorability, thermoplasticity, absence of odor and taste, toughness, water resistance.	Coatings, films, sound records, storage batteries, wall board coatings, laminations, shoe parts, suspenders and belts.
Polyvinyl butyral	Butacite, Butvar, Saflex, Vinylite X (butyral)	Adhesiveness, moisture resistance, toughness at winter and summer temperatures, transparency.	Sheet platic for safety glass, army raincoat linings (substitute for rubber), bonding resin, flexble molded and extruded articles, self-sealing fuel tanks, gas-impermeable fabrics.
STYRENE			
	Styron, Lustron, Loalin, Bakelite polystyrene	Thermoplasticity, colorability, lightness, absence of odor and taste, water and chemical resistance, electrical qualities, injection and extrusion molding, low specific gravity.	Bottle closures, radio parts, refrigerator parts, dishes, transparent automotive accessories, edge-lighted instruments, co-axial cable insulation, battery boxes, electrical products.
ACRYLICS			
Methyl Methacrylate	Lucite, Crystallite, Plexiglas	Colorability, edge-lighting effect, dimensional stability, rigidity, transparency, water resistance.	Aircraft and marine enclosures, dentures, dresser sets and tableware, displays, signs, reflectors for highway lighting.
CASEIN			
	Ameroid, Galorn	Colorability, machinability, non-flammablity, hygroscopicity.	Buttons, buckles, game novelties.

In the above outline are not included some of the synthetic resins used for protective coatings, known as the alkyds, nor the numerous types of synthetic rubbers, such as Buna, butyl, Neoprene, Thiokol, Vistanex, and so on.

Copolymerization of two or more polymerizable substances, such as vinyl chloride and vinyl acetate, has led to useful products, such as Vinylite. If a part of the acetate radical is hydrolyzed and the resultant product is treated with an aldehyde, the so-called polyvinyl acetals are obtained. When butyric aldehyde is used, for example, the product is known as Butvar or Butacite, which find extensive application in laminated glass and recently as a coating for Army raincoats in place of rubber.

Another vinyl resin, which appeared in 1930 as an opaque molding powder, is styrene, or vinyl benzene. In this, one of the hydrogen atoms of the benzene ring is replaced by a vinyl radical. This product is a crystal-clear thermoplastic with density approaching that of water

Akin to the vinyls are the acrylic resins, which are forms of vinyl compounds first investigated in Germany in 1901 by Dr. Otto Rohm and prepared industrially in 1931 in this country. Polymerized methyl methacrylate, such as Plexiglass and Lucite, is a product of rather recent origin, although this plastic had been produced commercially in Europe before its appearance in America about seven years ago. The resin has found application in "plastic noses" of bombers, cockpit enclosures, and so on.

Nylon is a rather late addition to the family of thermoplastics. It is made from adipic acid and hexamethylene diamine, both obtained by complex chemical synthesis from coal tar. It has become familiar to us chiefly as a textile material (stockings, bristles, fishing leaders, and so on) but not much specific information is available as to its potentialities in plastcs.

While concentrated studies have been going on in the synthetic resin field, research in the cellulosic field has also continued at an accelerated pace, and so we have the mixed cellulose esters, such as cellulose acetate butyrate, developed in the early thirties. Also developed with the cellulose esters were the so-called cellulose ethers, such as ethyl cellulose.

Thus, progress in the plastics industry continually goes on—new products and new processes are being developed each year, with the result that trade names are increasing, greatly to the confusion of the public. To clarify this picture of names, the accompanying table is offered. Because of the innummerable applications of the various types of plastics it would be impossible to present even a fairly comprehensive list, but the same table furnishes a general idea of the diversity of uses. The varied chemical and physical properties of the many thermoplastic and thermosetting plastics, with their particular advantages, fortunately permit a wide choice of selection and adaptation to specific tasks.

THE DISTRIBUTION of plastics is of necessity under heavy restrictions today. The Chief of the Thermoplastic Unit of the Chemical Division of the W.P.B., Ralph H. Ball, reported late last year that the majority of plastic materials are unavailable in sufficient quantity to meet war and essential civilian need.

While the cellulose plastics have been using cotton linters as the basic raw material, research studies are being expedited to extend the utilization of wood pulp in making plastics. Lignin, a wood product, is being investigated in government and private laboratories as a possible cheap raw material for making plastics in the building industry. Chemists also are at work on other raw materials such as soya bean, zein, and coffee, for making suitable plastics.

Indeed, it is felt that plastics will have attained a position at the end of this war which would have required four or five decades to reach in time of peace. To the layman it will become evident why plastic products, with their lightness, toughness, durability, infinite colorability, permanent finish, pleasant feel, chemical resistance, and fast molding cycles, have taken over many of the jobs of rubber, metals, ceramics, and other strategic materials.

It would startle John Wesley Hyatt today to see the fruits of his famous pioneer invention of the Celluloid billard ball about 75 years ago!

Glass ampoules containing iodine and mercurochrome are now protected by transparent plastic tubes. Thus, when the tube is broken, the fingers are protected from slivers

Conducted by KEITH HENNEY

Motors Do A Better Job

By Means of Electron Tubes, Direct-Current Motors Can be Operated From Alternating-Current Power Lines. The Advantages are Variable Speed Over a Wide Range, Constant Torque at Slow Speeds, Constant Horsepower at High Speeds. Many Industrial Applications Listed

One of the oldest and most prosaic of industrial tools, the electric motor, is about to feel the full effect of the newest and most versatile of industry's tools, the electron tube. By this combination of the old and the new, industry will be provided with a reliable variable-speed drive for increasing the usefulness of machine tools and other vital machinery powered with direct-current motors. No longer will it be necessary to use the motor-generator sets now required where only alternating current power is available, or belts and pulleys to change speed of an A.C. motor, or clutches and other mechanical means of adjusting speed. The elaborate equipment required for these inelegant methods of motor speed control can be released for more useful functions elsewhere, when the full impact of electronics is made effective.

Electric power is distributed to industry in two forms—alternating current and direct current. By the use of alternating current, it is possible to transmit huge quantities of power with only moderate losses in the transmission lines—a feature not possessed by a direct-current power transmission system. This is possible because of the ability to transform alternating current easily from one voltage to another. Since line losses go up with the square of the current transmitted, alternating-current power is transmitted at low current and high voltage.

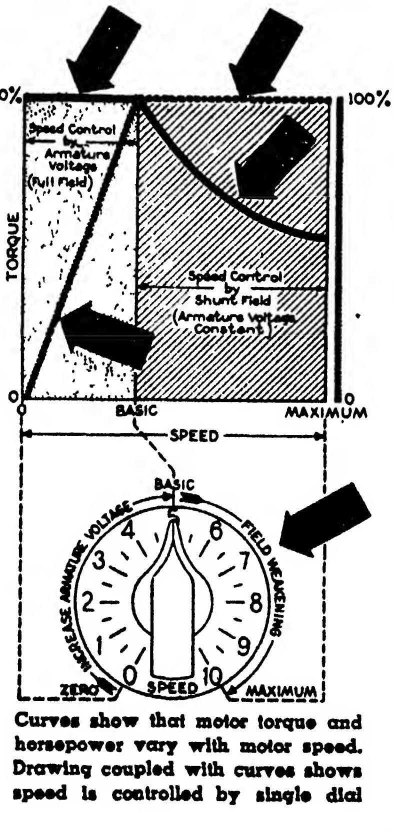
The big objection to the A.C. system comes when it is desired to utilize this power for certain jobs where variable speed motors must be used. Motors running on alternating current are unsuitable for driving lathes, driving conveyor belts, or feeding metal into cutting tools, for the simple reason that they have only a few fixed speeds depending upon the motor construction and the frequency of the current supplied to them. Beyond this speed range, accessory mechanical gear must be employed. What industry desires is the flexibility of the direct-current motor and the efficiency of transmission of the alternating-current system. Electronics now makes this possible.

To overcome the disadvantages of alternating-current power, many industrial plants now buy this power and use it to run an alternating-current motor to which is mechanically connected a direct-current generator. The direct current power thus obtained is used to supply variable-speed direct-current motors. Speed is changed by throwing away or absorbing some of the generated power. The disadvantages of this system are obvious.

Other plants generate their own direct-current power from prime movers, but this is usually uneconomical.

Electron-tube control of motors operated from alternating-current, therefore, not only improves the efficiency of the system where variable-speed drive is essential, but new advantages not evident at first sight are made possible.

For example, an ordinary motor operated from direct current does not fulfill *all* requirements such as extremely wide and stable speed range, good speed regulation, smooth automatic acceleration. The tube-motor combination provides these features plus the advantage that the speed of the motor may be preset so that the forward or reverse speed is obtained merely by pushing the proper button. Then, too, speed may be changed at any time while the motor is running, providing constant torque over the entire armature control speed range and constant horsepower over the field control range, as well as elimination of vibration difficulties sometimes encountered with adjustable-speed drives. This is especially important in providing power for machine tools where vibration might throw the tools out of alignment.



Curves show that motor torque and horsepower vary with motor speed. Drawing coupled with curves shows speed is controlled by single dial

The basic method by which electron tubes are added to a motor is simple. The tubes employed are thyratrons. These are gaseous or mercury-vapor filled rectifiers which convert alternating current into direct current. They differ from ordinary rectifier tubes in that a third element, a grid, is added to the required cathode (supplier of electrons) and anode (receiver of electrons). A rectifier, like any other electron tube, conducts current only when the anode is positive with respect to the cathode. Thus if a load to which power is to be fed is placed in series with a rectifier and a source of alternating-current power, current will flow through the load only on the half cycles of the alternating-current power when the anode is positive. Current, therefore, flows only part of the time but during this half cycle it flows continuously—not for half of a half-cycle nor for a quarter of it but for all of it. The only time the current does not flow is when the anode becomes negative with respect to the cathode, and this occurs on the alternate half cycles when the direction of current flow reverses.

With a grid interposed between cathode and anode, however, the situation is different. Now the portion of the positive half cycle during which current flows through the tube and, therefore, through the load, can be varied by merely changing the voltages on the grid with respect to the anode or the phase of the alternating voltages placed upon grid and anode. Thus a thyratron is a controlled rectifier; by proper circuit arrangement the current through the load may be anything between zero and the maximum passed when the tube conducts throughout the positive half cycle.

The grid inside the tube is connected to a speed control dial in front of the operator. Turning this dial varies the voltage on the grid so that it acts as a faucet, opening to let more power pass through the tube to the motor or closing to reduce the stream of power.

A direct-current motor operated from alternating current by means of a thyratron is supplied with rectified A.C. power. The system consists of a single or polyphase, grid-controlled, thyratron tube rectifier which takes power from the A.C. line and rectifies it into direct-current ouput. The rectified D.C. voltage is supplied to a regular shunt-wound D.C. motor and may be varied from zero to motor rated voltage (or above) for D.C. armature control. Smaller thyratron tubes used in the control apparatus provide rectified D.C. current for the

field of the motor. The field voltage is held constant throughout the range of armature voltage and then is reduced to provide greater speed range by field weakening above the base speed of the motor.

Only four pieces of equipment are required for electronic motor control. These are a transformer, the electronic unit, the control (push-button) station, and finally the motor to be controlled.

An anode transformer is used in order to make use of motors of standard voltage. By designing a special motor it would be possible to eliminate this transformer entirely in most cases, but manufacturers (notably General Electric, which has developed the Thy-mo-trol system and Westinghouse the Mot-O-Trol) have felt that the use of a motor of standard design has definite advantages to the user. The speed control dial and the push buttons may be mounted in any convenient location.

The normal speed range by armature control is 20 to 1 below the base speed of the motor, although a much wider range such as 100 to 1 can be obtained. Field current control is used above the base speed for standard motors. This range is normally 2 to 1, with the top speed naturally limited by the characteristics of the motor itself. The electronic circuits automatically regulate the motor speed in order to maintain it essentially constant at any setting regardless of load. Through other smaller control tubes, the D.C. output voltage of the main rectifier tubes is controlled to compensate for speed changes. In a properly adjusted system, the speed over a 10 to 1 range will not vary more than 4 percent from a presetting, with torque varying from no load to full load. Furthermore, the speed will not vary more than 8 percent for any speed within the speed range of 20 to 1. Normal variations in A.C. line voltage have only a small effect on the speed regulation.

In a typical case, the speed will not vary more than plus or minus 1 percent if the line voltage varies as much as plus or minus 5 percent.

When the stop button is pushed, a resistor is automatically connected across the armature. In this way the motor is brought to a quick stop through dynamic braking. The current is interrupted by the thyratron tubes rather than by a magnetic contactor.

Electronic motor control of the type described has the following advantages:

1. All the desirable characteristics of a D.C. motor drive from an A.C. supply.

2. Only one rotating element (the motor), consequently no vibration trouble from auxiliary equipment.

3. Ease of mounting: Control may be mounted in its own cabinet or built into suitable space in machine.

4. Finger tip control: No field rheostats required; speed control in regular push-button station.

5. Adjustable accelerating torque to meet various load requirements. Smooth automatic acceleration.

6. Much wider ranges than normal with stable operation at extremely low speeds and exceptionally good speed regulation under varying load conditions.

7. Preset speeds.

At present, electronic control has been generally adapted to motors of one horsepower and smaller, although the manufacturers have successfully applied the equipment to motors of considerably higher power.

Many interesting applications have been made, most of them to machine tools because of the present limitations in size. Among the types of machines to which electronic drives have been successfully applied are grinders, milling machines, tool-room lathes, turret lathes, and thread mills. In addition, they have been supplied for automatic welding machines and for various special equipment for testing magnetos, airplane-propeller governors, and instrument tachometers.

A particularly interesting application has been made for driving the headstock on grinders. The wide speed range obtainable and the constant-torque characteristics provided at low speed make it possible to provide the proper speed for every type of grind. In several instances the new control has made possible a simplification in the headstock itself through the elimination of the gears and pulleys formerly required.

One of the earlier applications of this form of motor control was in the field of astronomy, where electronic

TYPICAL INDUSTRIAL APPLICATIONS OF THE ADJUSTABLE-SPEED ELECTRONIC MOTOR DRIVE

Industry	*Application*	*Operating Requirements*
Aviation	General purpose testing, machinery, such as for fuel pumps	Wide speed range; stepless acceleration
Cement	Conveyors	Constant speed for any speed setting
Ceramic	Lathe drives	Adjustable speed
Chemical	Feeders (conveyors or pumps)	Adjustable speed; close speed regulation at any speed
Food	Bottling and packaging machines	Medium speed range; close adjustment
Laundry	Flatwork ironers	Adjustable speed; constant torque
Machine Tools	For all machine tool feeds, such as on lathes, grinders, and milling machines	Wide speed range; good speed regulation, reversing dynamic braking
	Slotters, key seaters and gear cutters	Adjustable speed, good regulation
Glass	Glass drawing	Wide speed; close speed regulation
Materials Handling (all industries)	Feeder conveyors Assembly conveyors	Adjustable speed; high starting torque
Steel Mill	Straightening machines	Adjustable speed; frequent starting, dynamic braking
	Spinning or flanging machine feed	Adjustable speed; high torque at low speeds; braking
	Cold or hot saw feed	Adjustable speed; good regulation
Mining	Ore concentrators	Constant speed for any speed setting
Paper	Wire shakes and rotating filters	Medium speed range; uniform speed
	Rotary cutters, slitters, winders and single intake shaft drive on combining, waxing or paper treating machines	Low threading speed, medium speed range; close regulation at any speed setting; smooth, stepless acceleration
	Reels	Accurate speed setting; wide speed range
	Top roll drive and dandy roll drive	Medium speed range; close regulation
Paper Converting	Bag machines, folders, interfolders, creasing, perforating and embossing machinery	Low threading speed; constant speed at any speed setting; stepless smooth acceleration
	Laminating and coating machines	Wide speed range; stepless acceleration
Power Generation, Heating and Ventilating	Coal Feeders	Adjustable speed; constant torque.
	Stokers	Wide range of speed, close regulation
Printing	Small web-feed rotary printing presses	Inching; dynamic braking; close regulation at any speed; smooth acceleration
Rubber	Small tubing machines	Adjustable speed; good regulation
Textile	Warpers and winding reels	Constant linear speed at any given setting
	Starch mangles, padders, and sanforizers	Wide speed range; close regulation
Woodworking	Lathe feed	Wide speed range; constant torque

Adjusting speed compensation control on cabinet of Westinghouse Mot-O-Trol. Thyratrons are in cabinet

tubes were used in connection with the driving motors for huge telescopes. Since then, the extreme flexibility of electronic motor control has resulted in many other applications in the fields of pure science and research—applications that undoubtedly will eventually result in important new industrial uses as well.

Elevator installations lend themselves naturally to electronic control, particularly in districts where D.C. power is not available. Alternating-current motors cannot economically provide the high starting torques and wide speed ranges required in this application; hence D.C. motors must be used. Where only A.C. is available, the choice lies between providing a D.C. source of power by means of a motor-generator set or small power plant, or using electronic control to run D.C. motors from A.C. lines. The final decision is usually governed by a study of relative costs, with the award going more and more often now to electronics.

⊕ ⊕ ⊕

PHOTO-TUBES CONTROL POWER

Automatically Control Flow in Testing Demand Meters

ELECTRIC meters for measuring electrical energy sold to users measure the product of power and time. To test such a meter for accuracy requires measuring two quantities. Since time is easily measured to high accuracy, it is common practice to hold power constant and measure time.

Some types of demand meters may require test periods up to 15 minutes, other types to one hour. When such tests are performed manually, an operator observes the motion of the pointer on a standard wattmeter and by adjusting a rheostat controls a portion of the total test load to correct for the small variations arising from voltage fluctuations, resistor heating, and other causes.

The operator learns by experience that in order to keep the average of the load constant he must try to compensate for the transient variations by briefly applying a greater correction than the deviation, the operator thus mentally averaging the peaks and dips. This is a somewhat tedious operation involving both judgment and eye-strain.

A method of doing this important job automatically by means of photo-tubes has been developed at the Westinghouse Electric and Manufacturing Company, and was recently described in *Electronics*. The apparatus has three parts corresponding to an operator's eye, brain, and hand, according to B. E. Lenahan. The "eye" part consists of a mirror which receives a beam of light from a lamp, also two photo-tubes, and a shutter vane carried on the meter mechanism. The shutter moves in front of the mirror and forms an optical lever to magnify the movement of the meter coil. So long as the coil is in its correct position, indicating the flow of the desired amount of power, the output of the photo-tubes is zero, but when the meter coil moves, the photo-tube output is proportional to the displacement of the meter movement.

The "brain" part of the apparatus consists of a network of resistors and condensers, and the correction mechanism, using amplifier tubes, performs the "hand" operations ordinarily required. Thus the combination of photo-tubes and correction system replaces two operators by one, and increases accuracy.

OIL MIST PRECIPITATED

Electrical Charging Removes Fire Hazard in Shops

HIGHER operating speeds of modern machine tools, causing greater breaking up of coolant oil into mist; increased machine-hours per day which plants now work; increased number of machines in a given space — all these factors increase the oil smoke and mist problem in many machine shops. The effect is to reduce the effective illumination on the work and to create a fire hazard. Several methods of cleaning the air have been devised, and one using the Precipitron electronic tube seems to have particular merit. The Precipitron is a development of Westinghouse engineers by which high voltage precipitates dust and other particles in the air by charging them with electricity. A comparison test between a mechanical air cleaner and a Precipitron, both operating at a rate of 600 cubic feet per minute, showed that the electronic machine was at least seven times as efficient.

OFF-FREQUENCY TUNING

Phenomenon Now Being Usefully Applied

EVERYONE knows that as a radio receiver is tuned away from the desired station, the strength of the signals from that station decreases. No one did much about this electrical phenomenon until a young man in the North woods put it to use in the early days of radio. He noted that the pitch emitted by his simple one-tube receiver varied if he placed a piece of paper between the condenser plates which tuned the set to resonance. This young man was interested in paper manufacture, and he knew that the moisture content of paper was important.

So he devised an electronic system which makes it possible automatically to control the amount of moisture in paper during manufacture It uses, essentially, this off-tuning phenomenon by which a voltage change is noted in an electrical circuit when the circuit is tuned away from resonance.

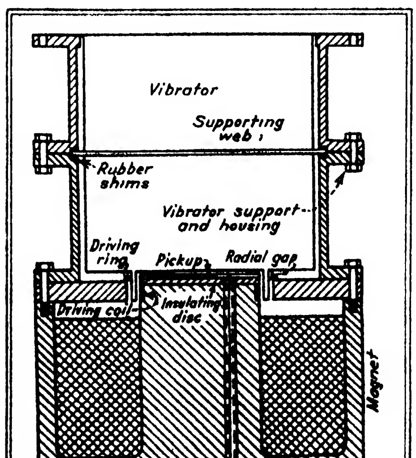
Many other uses have been made of this fact. Recently the United States Bureau of Mines has put the idea to work in a means of studying vibrations of the earth, in measuring and recording the elongation of test specimens being stretched, and in certain metallurgical uses.

AIR CLEANER

Utilizes Ultra-Sonic Waves Electronically Generated

IT HAS been known for some time that high-frequency sound waves will flocculate and remove suspended matter in smoke, fumes, or fog. One of the difficulties of putting this known fact into industrial use has been the problem of generating sufficient energy at frequencies higher than the human ear can hear. In the *Review of Scientific Instruments*, however, Hillary W. St. Clair described a generator which is a step in the right direction.

This producer of ultrasonic waves is built somewhat on the principle of the dynamic loud speaker used in nearly all radio receivers of today. The cone or diaphragm of the loud speaker is replaced by a resonant bar, and current is induced in this bar so that it vibrates at the required resonant frequency The vibrations of this bar can be imparted to the gas which is to be cleaned.



Cross-section of the new high-frequency sound generator designed for experimental air-cleaning work

Conducted by The Staff

SIMULTANEOUSLY today move two great rubber developments of far-reaching importance to the economic future of the Americas. These are the creation in the United States of a synthetic rubber industry and, in the tropical Americas, development of natural rubber production. Which of these two will win out in the long run? The answer holds large meaning for the tropical Americas which are producing strains of disease-resistant and higher-yielding rubber trees. In either case, science holds the answer—science in the industrial laboratory and science in agricultural experiment stations. Which will win in the long run? The chemist has produced many fateful changes in our economic life in the last two decades But probably no single development holds more potent possibilities than the race between the chemist and the agricultural scientist to supply the expanding needs of the Machine Age for rubber and to supply it cheaply and abundantly.

Rubber: Natural Or Synthetic?

Possibilities for the Development of Natural Rubber Sources on Small Family-Owned Plantations in the Western Hemisphere Loom as a Challenge to the Synthetic-Rubber Chemist in the Race for Domination of Post-War Markets

DR EARL N. BRESSMAN

Director, Inter-American Institute of Agricultural Sciences

IN OUR September issue, page 115, was presented an article on the present status of the synthetic rubber industry. We now publish a comprehensive survey of natural rubber, its present and possible future.

It is enlightening to study these two articles side by side. The one on synthetic rubber was, of course, prepared by a chemist; the present article is by a man whose main interest is in natural rubber.

If it, therefore, appears that there are discrepancies in statement between these two reports, it must be remembered that "only time and technology" can answer many of the questions involved. This is particularly true of discussions involving advantages for specific uses of different kinds of synthetic and natural rubbers, and the highly important cost element.—*The Editor.*

Americas. Rubber is indissolubly bound up with the economic destinies of the hemisphere. What rubber means to our motor and machine age has been well illustrated in the repercussions from the loss of rubber supplies in the Far East.

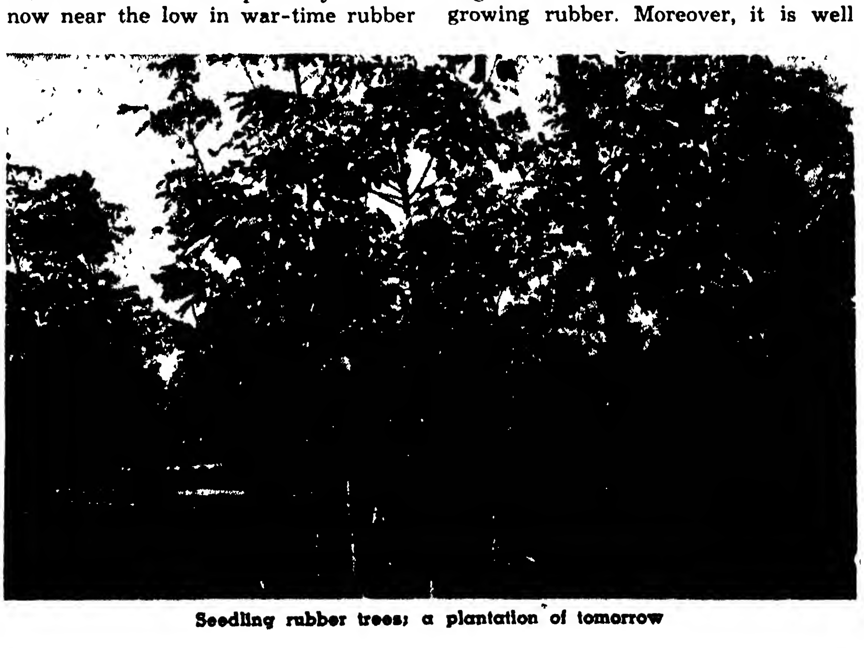
Right now the important thing is to get rubber. We must get it from any and every source available, natural and synthetic, as quickly as possible. That is all that matters immediately. Without rubber, the United Nations war machine and the civilian economy of the Americas would be severely handicapped. Lack of rubber can prolong the war. Lack of rubber can cause infinite confusion in civilian life, as we know only too well. Still it is worthwhile to examine now the challenging question: Are we to rely, in the long-range aspects, upon natural or synthetic rubber?

Perhaps the combined answer to this challenging question lies in the test tubes of patient chemists and in the research and experiment stations of the

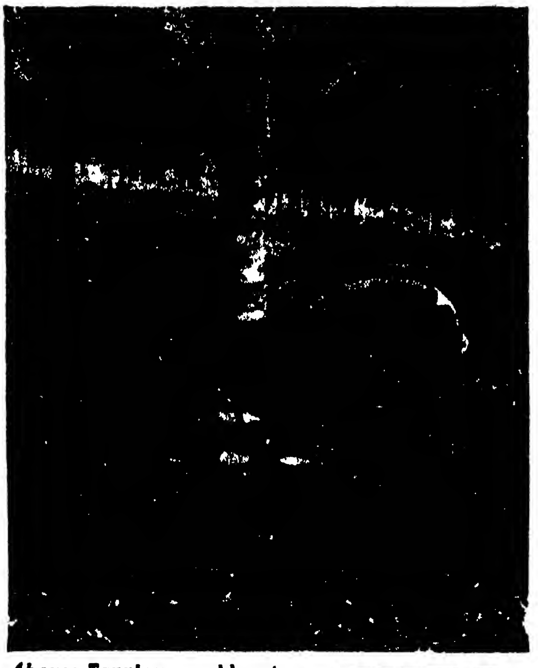
Much of the natural rubber program for immediate war needs is concentrated on efforts to increase quickly the production of wild rubber in the Amazon basin and in Central America. The program also includes large projects for production of rubber from quick-growing plants, such as cryptostegia and guayule. World rubber consumption in the past few decades has increased rapidly. The curve of consumption, both in the United States and outside the United States, seems likely to continue to rice for a long time. Temporarily, in the United States, consumption is limited by need of conserving available supplies for war and for essential civilian use. But probably we are now near the low in war-time rubber consumption. Starting in 1944, the curve of both production and consumption may resume its climb. I believe United States consumption of rubber will expand until it at least doubles consumption during the peak year of 1941. In that year the United States used around 775,000 tons. If I am correct in this assumption, the long-term uptrend in rubber consumption will mean that the United States eventually will require 1,500,000 tons of rubber annually. That means a billion dollar industry. The United States Department of Agriculture, in collaboration with the tropical Americas, is carrying on research for the improvement of plant materials and for commercial stimulation of existing strains resistant to leaf blight as well as of high-yielding strains. In the 100 co-operative nurseries established in the other Americas, nearly 30,000,000 budded trees already have been produced. These are material for the plantation industry. Five experiment stations strategically located are making available scientific research and guidance for development of plantations, small and large. The Institute of Agricultural Sciences is preparing to take an active hand in this program, in collaboration with experiment stations of the other Americas.

Thus we see taking shape the dreams of those who years ago saw the need for growing rubber supplies closer to home Now the essential plant material, consisting of Hevea rubber trees of high yields and disease-resistant strains from the Orient, developed in the tropical Americas, is available for further expansion of a natural rubber industry in the Americas.

The most important of the co-operative field stations is located at Turrialba, near San Jose, the capital of Costa Rica. This station, started in 1940, is fully equipped and stocked. It possesses ample land for nurseries, clone collections, and other limited plantings. Turrialba was selected as the site because it is ideal for investigation of the most serious pest of the rubber tree in this hemisphere, the South American leaf blight. The volcanic soil is excellent for growing rubber. Moreover, it is well



Seedling rubber trees; a plantation of tomorrow



Above: Tapping a rubber tree for latex. *Right:* The "tree equivalent" of the synthetic-rubber plant—storage tanks for holding butadiene and styrene

situated to collaborate with the Inter-American Institute of Agricultural Sciences in future research.

The government of Costa Rica has provided a thousand-hectare experiment station, known as "Los Diamantes," near Cuapiles, about 50 miles from Turrialba. This farm is less than 1000 feet above sea level and is representative of the broad northern coastal plain, which is well adapted for rubber growing. It will serve primarily as a propagation garden to supply bud wood to growers in regions infected by the leaf blight.

Another important co-operative field laboratory is at Belem, Brazil, gateway to the Amazon rubber country. This laboratory is located at the Instituto Agronomico de Horte, operated by the Brazilian Department of Agriculture. Considering its strategic position, the Belem center may have a key role in the development of rubber production in the Amazon basin. Studies will be carried on there in different kinds of Hevea rubber indigenous to the Amazon country. Scientists will collect bud wood and seeds of superior trees. Up-river stations will be established to carry on agronomic research. Improvement in tapping methods and preparation of rubber from wild trees are receiving special attention in view of the need of rubber for war purposes.

In Haiti, a co-operative field station has been established at Marfranc for propagation of planting material. This material will be available for distribution locally and to nearby countries. The leaf blight has not been found in Haiti. Strains of Hevea rubber susceptible to leaf blight will be crossed with resistant selections from the jungles of South America at the Marfranc station.

The co-operative field station at Tela, Honduras, is located at the famous Lancetilla Farm, research station of the United Fruit Company. Two plantations of mature seedling rubber trees planted in 1926 by the United Fruit Company are sources of seed used for root stock production. In addition, some of these mature trees are used in developing techniques for small-scale or family size rubber enterprises.

In Mexico, co-operative projects are under way with the Ministry of Agriculture at the El Palmar experiment station near the city of Tezonapa, state of Vera Cruz. Some 300 acres of mature rubber trees near this station provide ample seeds for production of root stocks and are under investigation for superior clones. Some of the latter, following blight-resistant tests at Turrialba, may prove valuable for commercial planting.

In former times, when there was no competition to force rubber growers to develop special products for specific uses, the latex yield from all types of clones and rubber trees went to make up a conglomerate mass. This yielded a general or all-purpose product which had to serve wherever rubber was required. This all-purpose product, of course, had many shortcomings. In the last three or four years before Java and Sumatra fell to the Japs, the Dutch were beginning to make great strides in developing natural rubber for specific purposes. They had found that latex from different rubber trees, and particularly from different strains, varies greatly in its properties and that it was of value to keep the latex produced from different strains of trees separate for use where best adapted.

Chemists who advocate synthetic rubber on the basis that it has tremendous possibilities in developing products for specific uses, apparently lose sight of the fact that Nature is far ahead of them in the ability to produce different kinds of rubber adapted to specific uses. It is due largely to the fact that producers of natural rubber, particularly in this hemisphere, are not organized, that their product does not receive the wide and favorable publicity accorded synthetic rubber.

As regards price, there is no comparison, at present, between the two products—natural rubber is much the cheaper. Even if the raw material were to cost nothing, it seems illogical to expect that synthetic rubber could be polymerized out of either alcohol or petroleum in a city factory, paying high taxes and wages, overhead, and so on, at a price comparable to that involved in the production of natural rubber, which is an ideal small-family industry. It is to the interest of rubber consumers in this country to see that the rubber of the future comes from a really cheap source. In the future, it should be possible with fully mature plantations of high-yielding trees to produce rubber at 10 cents a pound or less.

RUBBER production is an ideal small-family industry. The Goodyear Rubber Plantations Company, which has carried on experiments with tropical American rubber production since 1935, has emphasized that, in the development of rubber production in this hemisphere, small plantings can play an important role. Although there are some large plantings, like those of Goodyear in Costa Rica and Ford in Brazil, in the future local farmers in those countries will be encouraged to make small plantings of a few acres and to utilize the large plantations and the co-operative experiment stations of the United States Department of Agriculture as sources of planting material.

No tropical crop is more suitable for farm production than is rubber. The mature trees are tapped and the latex is converted into dry rubber, usually smoked sheets, by a simple process which may be carried out with an investment in equipment of as little as $50. The equipment required consists of such materials as discarded oil drums, homemade wooden paddles, and crude smokehouses built with local materials.

The effectiveness of the family-operated farm in rubber production has been amply demonstrated in Haiti in connection with the Haitian-American Agricultural Development Corporation. There the women work on the farms just as men do. Whole families clear and till the land, harvest the crops, and transport them to market. That system is the foundation of the whole Haitian way of living, and any program that would tend to alter it would be doing Haiti a disservice. Small holders are demonstrating that not only can they cultivate rubber, but that they can produce it in competition with large holders to great advantage.

The good wages which rubber production brings the small family unit, providing them with a cash income to

supplement the living they get off their place, helps to develop contented rural populations. Contented rural populations will undoubtedly mean much more to the future of this hemisphere than some synthetic rubber factories run under high-tariff protection.

Vice President Wallace has said: "Looking ahead to the new time of peace, the motorists of the United States will not only want to have an assured source of rubber, but they will want to get that rubber as cheaply as possible. In the matter of cost, natural rubber from either the Far East or the Western Hemisphere is likely to have a big advantage over synthetic. And, even if synthetic rubber is available in large quantities at a low price, a substantial amount of natural rubber will still be needed for mixing with the synthetic product.

"Few automobile users in the United States realize that the technology of producing rubber from trees is changing almost as rapidly as the technology of producing synthetic rubber. During the last 10 years, high-yielding strains of rubber have been developed. Some of these strains yield two, three, four, and even five times as much as the old-fashioned strains customarily used in the Far East. With modern strains of the Hevea rubber plants, there is every reason to believe that during the period after the war rubber can be profitably laid down in New York City from either South America or the East Indies at less than 10 cents a pound. Therefore, to protect synthetic rubber produced in the United States from destructive competition would require a tariff of at least 10 cents a pound and probably 20 cents."

As previously indicated, natural rubber, under modern conditions, should not cost more than 10 cents a pound to produce and probably will be produced for less.

In this discussion, so far, in referring to the natural product, I have dealt exclusively with Hevea rubber. Hevea is preeminently the most important species for commercial rubber production, but there are other kinds which offer great possibilities, not only from the standpoint of low cost of production under proper conditions but specific qualities. In certain areas in Mexico and Central America conditions are more favorable to the growing of Castilla than Hevea rubber. In those areas, however, as in the West Indies, the Cryptostogin plant, a source of high-quality rubber, appears to offer emergency possibilities. Under ordinary growing conditions it will produce only 400 to 500 pounds of rubber per acre. Under the most favorable conditions, that is, with fertile soil and high rainfall, it is a potential source of more rubber per acre than any other rubber plant known. It is believed possible, with proper horticultural practices, to stimulate its fast-growing young water shoots or branches to yield over a ton of rubber to the acre. At present there are many unknown quantities in the production of Cryptostegia rubber. Good techniques for it can not be worked out until large-scale plantings, which are just being made, are in production.

Just what the chief source of our rubber will be 10 years from now no one can say with certainty. All signs, however, point to natural rubber as the product on which we shall rely mainly in the tremendously expanded industry of the future. Natural rubber has served our needs well in the past and there is every indication that it will continue to do so in an increasingly satisfactory way as time goes on.

● ● ●

GLASS THAT FLOATS

Foamglas Answers Many Insulating and Other Problems

GLASS, so light in weight that it floats, is the latest development in insulating materials; it is also applicable to life rafts, building blocks, and other uses. Foamglas, as the material is called by Pittsburgh Corning Corporation, is a true glass that has been cellulated by the evolution of internal gas at high temperature into a mass of tiny sealed air chambers, as many as 5,000,000 of them in a cubic foot. Foamglas is impervious to acid atmospheres or solutions and completely vermin-proof, and it can be easily cut into any shape by a cheap saw or knife.

The new product is remarkably light in weight—10 to 11 pounds per cubic foot, as against 156 pounds per cubic foot of ordinary glass. Because it is water-proof and consists of sealed cells, it is buoyant, and therefore especially adaptable for use in various types of floats and life rafts.

Foamglas provides highly effective insulation for cold-storage rooms and for buildings where reduction of heating costs or efficient operation of air-conditioning equipment are desired Dampness has no effect on this new achievement in glass, for, unlike most insulating materials, its conductivity does not increase under such conditions.

It is likewise excellent insulation for backup in many types of ovens and furnaces, up to a maximum temperature of 1000 degrees, Fahrenheit. Completely non-combustible itself, Foamglas is especially valuable where used as insulation in combination with materials not resistant to fire

ELECTRONIC "CHEMIST"

Will Speed Production Testing in Synthetic Rubber Plants

FASTER and more accurate than a dozen top-notch chemists, the mass spectrometer will soon accelerate wartime chemical research by freeing hundreds of highly skilled chemists from tedious but important production testing in synthetic rubber plants. The new instrument is a valuable laboratory tool for scientists seeking more powerful gasolines, new plastics, and improved synthetic rubber. An average college student can be taught to operate the spectrometer in a few weeks.

Dr. Hipple and electronic "chemist"

Developed by 32-year-old Dr. John A. Hipple, physicist at the Westinghouse Research Laboratories, the electronic "chemist" swiftly and precisely analyzes many of the complicated gases formed in making butadiene, the principal ingredient of several types of synthetic rubber.

"In 15 minutes," Dr. Hipple explains, "this spectrometer will dissect a complicated gas molecule a twenty-five-millionth of an inch long and can be arranged to produce automatically an autograph that tells the chemist the composition of the gas.

"At present, certain analyses require from 15 hours to three days of painstaking laboratory work by five to ten skilled chemists—others cannot be done at all even by other processes. Results attained by these tedious methods are much less accurate than the molecular 'portrait' that comes out of the spectrometer."

Butadiene molecules, Dr. Hipple explains, are carefully built up from carbon and hydrogen atoms according to definite chemical patterns, much as a tile-setter selects colored blocks to form a design on a floor.

"As the molecule is being put together in a butadiene plant," he says, "its composition must be checked at intervals to make certain that the chemical pattern is being followed.

"Present methods of determining the molecular structure are so slow that a batch of butadiene has often gone through the various treatments of the process before the analysis is completed. If there is an error in the molecular design, the butadiene will make a poor quality synthetic rubber. Sometimes a batch of butadiene has to be reprocessed, causing lost production time."

The spectrometer is housed in a cube-shaped cabinet five feet high. Its key part is a yard-long glass vacuum tube shaped into a quarter-circle. This tube, lined with metal, is fixed between the poles of an electromagnet. "Molecules of the gas being analyzed are

given an electrical charge at one end of the tube and are shot toward the other end at a speed of approximately a million feet a second by high voltage electricity," Dr. Hipple explains. "The electromagnet pulls at these speeding molecules so that only those having a certain mass, or weight, travel down the center of the tube, around the bend and through a tiny slit in a metal target at the other end.

"The molecules going through the target are collected on a metal plate where they give up their charges. Then the charges are amplified and counted by electric meters, which indicate how many molecules of a certain weight are in the mixture."

The mass spectrometer requires only a thimbleful of gas for each test. Butadiene plant chemists now have to draw off a bucketful of gas for the involved laboratory procedure of breaking down the mixture by "fractionating" or distilling.

SHIP PROPELLERS

Produced With a Substantial Saving of Critical Brass

ANOTHER indication of the wide-spread advances in metallurgy and foundry practices is found in the replacement by Meehanite Metal of brass in the production of propeller castings. According to Cooper-Bessemer officials, difficult one-piece, three-bladed propeller castings, being produced for United States Coast Guard vessels, have passed rigid inspection and testing, proving that Meehanite Metal has the strength and structural characteristics necessary for this application Meehanite Metal, with a far higher tensile strength range than ordinary cast iron, has been used with great succeess by Cooper-Bessemer for several years in the production of engine castings.

Conversion to Meehanite castings is said to have reduced propeller production costs as much as 50 percent, in addition to conserving a substantial tonnage of critical brass which can be used in fabricating other vital war equipment.

MATHEMATICAL DESIGN

Can Replace Slower Mechanical Tests

PRODUCTION of airplanes, tanks, and other armament will be speeded by a unique method, developed in the civil engineering laboratories of Cooper Union, which eliminates the use of models in determining how complicated parts will react to stress.

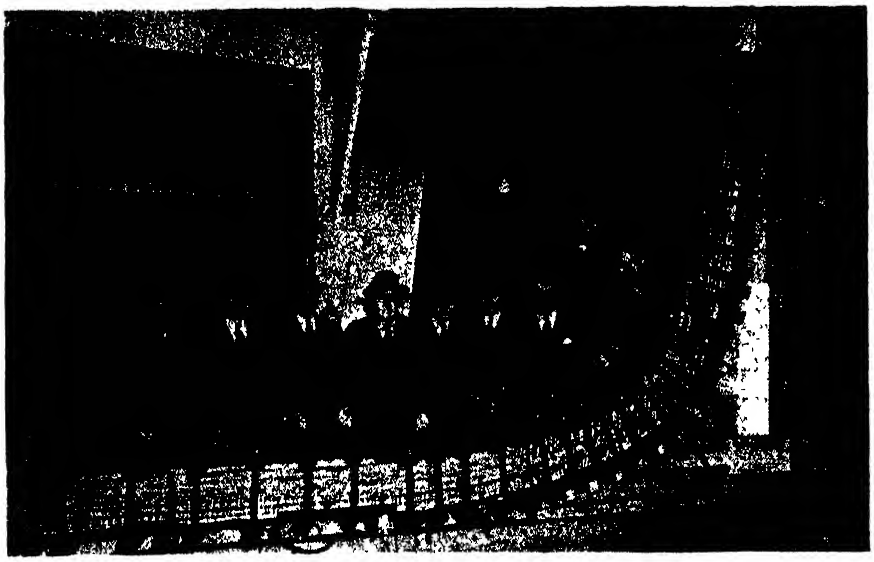
Valuable time and effort in the design of modern complex structures is saved by the new method, which embodies a theoretical approach utilizing mechanics and mathematical formulas, according to Ray C. Brunfield, associate professor of civil engineering at Cooper Union and originator of the method.

"Much equipment now being designed — airplanes, tanks, armament, and many other modern machines — contains portions which are known as indeterminate structures." Professor Brumfield explains. "They are out-of-the-ordinary beams, beams that may be swelled, pinched, curved, or of any other odd construction. The problem is to determine in advance what effect the loads that will be borne by a particular structure will have in inducing stress.

"With so many variable factôrs involved, the old trial-and error methods of predicting just how much rough treatment the parts of a structure can withstand are time-consuming, tedious, and expensive.

"A refined form of trial and error, the use of models to determine reaction to stress, is widely used throughout industry. Many indeterminate structures are now being designed by means of Bakelite or other plastic models. The models are placed under stress conditions similar to those to which the completed structure will be subjected, and polarized light is passed through the model. The light shows up the effect of the stress conditions.

"Another method used is to make models of plaster of Paris or glass, which break under stress conditions and reveal weaknesses of design. Both methods are entirely adequate for computing stresses, but today speed and efficiency are a prime consideration."



Prior to removing clamps from a new laminated ship's backbone

The Brumfield method of computing stresses is done on paper, by means of mechanics and mathematical analyses "under laws similar to which common types of structures are designed."

"Stress analysis is a very important part of construction," Professor Brumfield points out "Its function is to effect a design so proportioned that the structure will do its job and remain intact in its original form despite the operation of normal stress conditions."

SHIP'S BACKBONE

Now Made of "One Piece" of Laminated Wood

THE IDEAL backbone of a wooden ship — stem, keel, and stern post all in one piece — is now an actuality due to recent progress in wood lamination, using low-temperature phenol glues; shipwrights had never achieved this ideal before, for nature never grew oak trees of the required dimensions and configuration.

Rapid developments in plywood, coupled with research in resin glues, led naturally to the inquiry as to whether lamination wasn't the answer to this problem. Plywood's known strength, greater, weight for weight, than that of steel, led to utilization of laminated woods for trusses in factory and other large construction. But problems of shipbuilding are unique. Stresses and strains are mobile and variable, and no ship can be stronger than its backbone. Laminations must not only be waterproof, but also resistant to the action of salt water.

Experimentation began in 1940, when the Navy recognized the imminent possibility of increased ship construction. With the assistance of technicians of the National Lumber Manufacturers Association, search began for the type of glue that would meet these requirements.

Tried first were phenol resin glues which set at high temperatures, for their effectiveness in marine plywood was known But laminated wood members use layers much thicker than the thin veneers of plywood, and difficulty was encountered in transmitting the necessary heat through these layers.

Urea resin glues, setting at from 70 to 80 degrees, Fahrenheit, were tried. Frames of two 50-foot vessels were laminated of white oak, and exposed to water for a year. While these glues are considered waterproof, salt-water reaction resulted in delamination and reduced strength at the glue line.

The next experiment resorted to low-temperature phenols, especially those in which alkali accelerators are used. A stem, keel, and horn timber for a heavily constructed ship were built and subjected to salt water. Exposure and laboratory tests both indicate these glues will prove thoroughly satisfactory.

To solve the heat problem, a high-frequency electrostatic field was tried to set the glue. While this experiment has had promise of success, new glues, requiring lower temperatures, have been another solution. But the low temperature phenols still require higher temperatures than urea resins, it having been found that phenol glues, set at 200 degrees, holds laminations together with the strength of the wood itself.

This method of creating big pieces by uniting small pieces has several special advantages. The finished product is, in effect, one piece. It is four to eight times as strong as bolted keels. Glued frames are stronger than steam bent frames. Proper moisture content can be readily controlled. Prefabrication, reducing labor in the shipyard, is made possible. Because of greater strength, weight can be reduced. For the same reason, materials may not be limited to the use of the traditional white oak.

Lamination makes unnecessary the search for special and rare timbers, thus ending one serious limitation on the number of wooden ships that can be built at one time. As far back as Civil War days, fear was expressed that enough timber suitable for naval construction could not be found. While we are building no more frigates of wood, demands for wooden scouting craft, mine sweepers and various types of combat vessels have reached large proportions, and lamination now seems certain to play an important role in their construction.

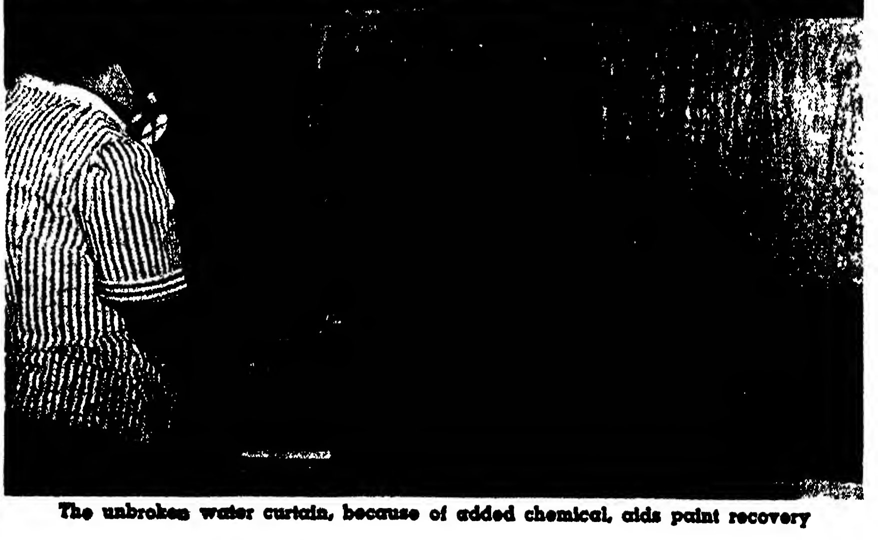
PAINT RECOVERY

Assisted by Additive to Water Curtain Spray

A NEW and important use in the War Production Board's paint recovery program was discovered recently for a chemical compound known as Turco Deflocculator. Paint overspray collected from water wash curtain spray booths which used circulating water treated with Turco Deflocculator lent themselves better to recovery and produced a recovered paint of the highest quality, according to test runs recently made at the Southern California area reclamation factory.

When the deflocculator was originally designed as a chemical treatment for circulating water systems in paint spray booths, its sole purpose was to prevent breaks in the water curtain by emulsifying oil and resinous vehicles and dispersing pigments so that they could not deposit on the metal walls of the spray booth.

Now, without changing the method or directions for using the compound,



The unbroken water curtain, because of added chemical, aids paint recovery

the chemical compound serves a double duty. At the same time that the dilute solution of the compound (an initial charge of 1/3 ounce to the gallon of water, with further additions of 1/6 ounce per gallon every four hours) is acting to prevent breaks in the water curtain and maintaining an unbroken sheet, it also serves as a chemical recovery agent. By preventing the formation of scum on the top of tanks, the deflocculator aids in producing a higher quality of sludge which stays smoother and is dispersed easier after reclaiming.

INDUSTRIAL BURNS
Treated With Tannic Acid
In New Package

According to "Accident Facts" published by the National Safety Council, approximately 4½ percent of the industrial accidents known to the council were accounted for by burns and scalds. V. A. Zimmer, Director of the United States Department of Labor's Division of Labor Standards, has estimated that industrial accidents cost the nation 250,000,000 man days in 1941. This involved millions of workers who were absent from their jobs because of injury or accident in the plant. So, based upon a 4½ percent known estimate or reported accidents from burns, this means that 11,250,000 production days were lost, caused by burns and scalds.

As a means of reducing man-hour loss from industrial burns, The Gebauer Chemical Company has prepared a stable tannic acid solution which is marketed under the name of Gebauer's Tannic Spray. The bottle is unique in that its closure is an automatic device which permits the spraying of the solution directly from the bottle over the affected burn area. The manufacturer makes special emphasis of the fact that the first five minutes are the most important in the treatment of burns and that if first and second degree burns are treated promptly, within a few minutes after they have occurred, with any good, recognized medicament, the probability of blister formation, infection, and other complications is materially reduced.

The manufacturer further claims that this tannic spray solution is stable, antiseptic, and that it forms a tannic film over the area to which it is applied.

INTELLIGENT SELFISHNESS
Has Sound Basis in the
Science of Psychiatry

Man's instincts and feelings supply the energy which makes the mind work. There is no other source of his animation and desire to live and thrive. Without the raw instinct of self-preservation, man would be inert, almost as in a stupor, with but a few feeble reflexes left to indicate that life exists. It is energy derived from the baser instincts which enables a man to awake, to dress, to eat, to go to work; it is a crude self-serving feeling, which, when refined by intelligence, causes him to care for his children, to make love, to fight battles, to build cities, to paint pictures, and to compose divine music.

If the instinct to acquire and to desire things were absent, man would be incapable of ambition, would be torpid as to his own welfare, could not provide for his family and would be utterly indifferent as far as pride, self-esteem is concerned. Total accomplishment would be almost nil.

This concept becomes clearer when we inspect man's nature from the biologist's point of view. What is the value of basic selfishness or the so-called acquisitive instinct? The answer is obvious — it has an undeniable survival value. The purpose of selfishness is to provide man with energy for survival by acquisition of things which mean material comfort and security for himself and his family.

To the moralists, selfishness is undesirable and is considered to be something opposed to honesty, charity, ambition, and other virtues. To them, it is a base-instinct that is incapable of being refined by intelligence to become something desirable. They do not stop to consider that, like other instincts, selfishness has passed through evolutionary stages. In the primitive savage, it is "raw" and seeks direct satisfaction by simply stealing.

As social life improved, the desire to acquire did not diminish, but man learned, as the child learns, to defer desire, to recognize that the same goal can be achieved by devious strategies, and by socially approved techniques. Thus he attained two advantages; he obtained what he desired and at the same time incurred less hard feeling in his social setting.

Intelligence is, therefore, nothing more than a device whereby one satisfies instinctual desires with social approbation. The criminal who steals is simply stupid; the philanthropist has satisfied the same instinct of selfishness by elaborate intellectualization of this instinct and is therefore a wise and

7 things you should do to keep prices down!

If prices soar, this war will last longer, and we could all go broke when it's over. Uncle Sam is fighting hard to keep prices *down*. But he can't do it alone. It's up to *you* to battle against any and every rising price! To help win the war and keep it from being a hollow victory afterward—you must *keep prices down*. And here's how you can do it:

1. BUY ONLY WHAT YOU NEED

Don't buy a *thing* unless you *cannot* get along without it. Spending can't create more goods. It makes them scarce and prices go up. So make everything you own last longer. "Use it up, wear it out, make it do, or do without."

2. PAY NO MORE THAN CEILING PRICES

If you do pay more, you're party to a black market that boosts prices. And if prices go up through the ceiling, your money will be worth less. Buy rationed goods only with stamps.

3. SUPPORT HIGHER TAXES

It's easier and cheaper to pay for the war as you go. And it's better to pay big taxes *now*—while you have the extra money to do it. Every dollar put into taxes means a dollar less to bid for scarce goods and boost prices.

4. PAY OFF OLD DEBTS

Paid-off debts make you independent now . . . and make your position a whale of a lot safer against the day you may be earning less. So pay off every cent you owe—and avoid making new debts as you'd avoid heiling Hitler!

5. DON'T ASK MORE MONEY

in wages, or in prices for goods you have to sell. That puts prices up for the things all of us buy. We're all in this war together—business men, farmers and workers. Increases come out of everybody's pocket—including *yours*.

6. SAVE FOR THE FUTURE

Money in the savings bank will come in handy for emergencies. And money in life insurance protects your family, protects you in old age. See that you're ready to meet any situation.

7. BUY WAR BONDS

and hold them. Buy as many as you can. Then cut corners to buy more. Bonds put money to work fighting the war instead of letting it shove up prices. They mean safety for you tomorrow. And they'll help keep prices down today.

KEEP PRICES DOWN . . .

Use it up . . . Wear it out . . .

Make it do . . . Or do without.

This advertisement, prepared by the War Advertising Council, is contributed by this magazine in cooperation with the Magazine Publishers of America.

honorable man. He has simply refined a baser instinct into exalted virtues by keeping an ear attuned for social approval. Such dynamic characteristics as ambition, reliability, enterprise, capability, and resourcefulness are nothing more than an intelligent harnessing of the instinct of selfishness.

This process of refining or elaborating a crude instinct to man's ultimate advantage is called sublimation. It signifies an intelligent utilization of instincts, desires, and tendencies, and is the most powerful incentive to work. Give a man an incentive to satisfy a prime instinct and his capacity to perform increases ten fold. No instinct in more propelling in this respect than is selfishness.

Labor without a sublimated selfishness is drudgery. To harness the instinct of selfishness in an intelligent manner produces a capacity to work which defies all the common laws of fatigue. It has little or nothing to do with the physical state A small hunchback who is working with instinctual satisfaction never tires, while the husky athlete who works for the sake of work alone, is listless and flabby at his tasks.

No man works harder and with greater zeal than the proprietor of a shop for the simple reason that he is satisfying the instinct of selfishness in an intelligent and accepted manner. Work is never an end unto itself — it is always a means to an end — to satisfy an innate selfish desire, whether it be to get a new refrigerator or to build a memorial hospital for charity.

The psychiatrist sees no incongruity in the term "intelligent selfishness." The concept has found sound application in industry as demonstrated by the policies of J. F. Lincoln He has been able to show that when the shop worker is allowed to utilize the instinct of selfishness to its fullest, his capacity for satisfying and non-fatiguing work is immeasurably increased. The principle is simple enough; the incentive being a participation in the profits in the form of bonuses and corporation shares.

STEEL CHEMICALS

A Few of the Jobs Being Done by Chemistry

STEEL IS processed by a host of chemicals from the moment explosives blast loose the ore until armor plate, tanks, bridge spans, or other finished products are delivered.

Chemicals to clean, surface-harden, electroplate, pickle, and perform other necessary operations on the metal are being manufactured in record quantities this year to match the unprecedented output of steel, according to E. I. du Pont de Nemours & Company.

Virtually every piece of steel going into ordnance must be thoroughly cleansed of oil, grease, and the like at least once, and usually many times, before it takes final form Both satisfactory inspection and the permanent adhesion of any finish require perfectly clean metal.

Chlorinated compounds — usually known as non-flammable, synthetic dry-cleaning fluids — now clean metal faster and more efficiently than any other known agent, by a method called "solvent degreasing." Oil and grease to the last speck dissolve in these chemicals or their vapors like sugar in water. Many parts vital to military equipment can be cleaned in large volume only by this method. Moreover, the work is done about four times as fast, and requires only about one-quarter the factory space.

The steel gears, bearings, cylinder sleeves, valve stems, and other essential parts of airplanes, guns, tanks, ships, and trucks would quickly break down under the full fury of mechanized warfare had not their surfaces previously been hardened and made wear-resistant by special chemical treatment.

One method for obtaining the required hard metal "case" is to treat steel in a bath containing molten sodium cyanide; another is "nitriding." In the latter, gaseous ammonia is flowed across steel under controlled conditions. Nitrogen in the ammonia combines with the surface layer of metal to form iron nitride—an extremely hard substance. Heat and time of processing determine the thickness of this protective "case."

Two pieces of steel often are joined together with copper by a unique process known as "brazing." Copper heated in the presence of hydrogen—

one of the two components of the chemical ammonia—flows out like oil over glass on the surfaces between the two pieces of steel. When cooled, it hardens and forms a permanent bond.

The heating and cooling of steel during various treatments would cause scaling if done in the air. Therefore, this operation is usually carried out in an atmosphere free of oxygen—for example, nitrogen-hydrogen, or nitrogen alone. "Bright annealing" is the apt name of this process, which assures a smooth, scaleless steel.

HEADBAND MAGNIFIER

Leaves Both Hands Free, Permits Use of Both Eyes

INSPECTORS as well as craftsmen doing high precision work frequently find need for a magnifier yet cannot use one which is fixed in position, or requires use of the hands. For such jobs there is available a Carl Zeiss binocular magnifier attached to a headband as shown in the accompanying illustrations.

Giving a magnification of 2¼ times, a practical power for most industrial purposes, the two lenses provide binocular vision which results in a large and clear field of view with ample depth for most work.

Magnifier leaves both hands free

No focusing adjustment is required and eyeglasses may be worn while using the magnifier. By raising the head slightly the eyes have an unobstructed view.

X-RAY TURNTABLE

Makes Possible Pictures from any Angle

AN X-ray machine incorporating a miniature turntable that enables physicians to change the position of a patient at will during delicate operations to remove foreign bodies from the lungs has been developed for the University of Pennsylvania Hospital, according to Westinghouse engineers.

The X-ray machine, called a biplane fluoroscope because it enables examinations to be made in two planes—horizontal and vertical—has been installed

X-ray pictures from any angle

in the Hospital's $200,000 department of radiology, one of the largest in the country. It will be used to locate such foreign bodies in the lungs as coins and safety pins.

"The turntable makes it possible to position a patient so that X-ray pictures can be made from any angle, even vertical, without lifting or turning him bodily," explains C. V. Aggers, Manager of the Westinghouse X-ray Division. "The result is greater safety and comfort for the patient, greater usefulness for the biplane fluoroscope."

Noting that examinations with the biplane device will be conducted in darkness, Mr. Aggers points out that all possible obstructions have been eliminated by design of the mechanism to assure freedom of movement in the examination room. The fluoroscopic assembly suspended from the ceiling and the examination table, riding on miniature trolley tracks across the revolving turntable, constitute the only visible portions of the apparatus. All other parts are concealed behind a wall panel and under the floor.

Aided by the biplane device, a specialist removes the foreign body by means of a small forceps which is passed through a tube in the patient's mouth to the lung.

LAMP FOR LIFE RAFTS

Projects a Beam Visible for 60 Nautical Miles

A MIDGET searchlight only as big as a walnut yet so powerful that it will project a 1500-candlepower beam visible for 60 nautical miles has been designed by Westinghouse engineers to aid the rescue of aviators forced down at sea. The new lamp provides the most powerful beam ever obtained from such a tiny incandescent unit, reports Ralph R. Brady, manager of commercial engineering at Westinghouse.

"Packed with the rubber life rafts with which all ocean-flying military aircraft now are equipped, one of the tiny lamps will be worn by each man of a plane crew forced down at sea," Mr. Brady declares. "The lights fit on a band around the head, like a miner's cap, so the man can have both hands

For use on life rafts

free to hold on during rough weather

"One half of the lamp bulb is silvered to provide a reflector," he says. "The lamp thus becomes a complete optical package in itself and requires no metal reflector or glass lens. An ordinary six-watt lamp diffuses its light in all directions whereas this lamp projects a beam that belies its size."

Navy specifications called for a lamp that would provide a light beam visible for at least 10 to 12 miles. Westinghouse engineers more than met the requirements by producing a lamp with a theoretical range of 60 nautical miles or about 70 land miles. Water vapor in the air reduces this range somewhat in actual practice, however.

"If burned all night long, one of the sea rescue lamps would last about 10 nights or 100 hours," Mr. Brady points out. The lamp is mounted in a waterproof housing to protect it from damage and contains a single tungsten filament.

METAL SALVAGE

Conducted on Intensive Scale

By Electrical Manufacturer

It's a familiar saying that every part of a pig is used except the squeal. Now this axiom is the catch-word at the Stromberg-Carlson Company, where equal care is taken to make certain that not a bit of the metal used in the manufacture of radio and telephone equipment for the armed forces is wasted.

The firm began an intensive salvage program several months ago and since that time tons of brass, aluminum, bronze, steel, lead, and copper, which, as manufacturing waste were normally thrown away, have been turned back into industry to be processed into useable material.

Large metal pieces such as aluminum, copper, and brass stampings are first sorted according to size and quality and then turned over to nearby metal foundries for re-smelting. Scraps of this type average well over 58,000 pounds a month. Steel borings and stampings net more than 38,000 pounds in a month's time.

From craftsmen's benches, where

delicate electrical apparatus is assembled, come a large supply of usually-wasted solder drippings. This now-valuable metal, which splatters from the workmen's soldering-irons, is sent to a lead works at a monthly rate of 300 pounds.

Even small copper wire ends, snipped off during wiring assembly, are retrieved, along with worn copper tips of soldering-irons, running into more than 250 pounds every month. Discarded braided wire is accumulated, the insulation burned off, and stored for salvage. Tiny, powder-fine metal filings are tediously collected, and packaged for the smelters.

Defective radio tubes, amounting to 125 pounds a month, are turned over to refineries which retrieve the valuable nickel, gold, silver, tungsten, and brass which make up their construction.

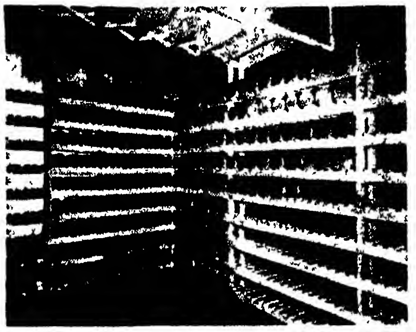
CONCRETE CURING

Test Sections Kept in Air-Conditioned Room

SPECIMENS to test durability and strength of all concrete going into the construction of dams, highways, buildings, and sidewalks by the City and County of Denver, Colorado, are cured in a Carrier air-conditioned room at the Materials Laboratory of the Denver city government.

To test concrete's "curing" propensities, the laboratory has constructed a storage room approximately 14 by 18 feet, in which a temperature of 70 degrees, Fahrenheit, and 100 percent relative humidity are maintained the year around with variations of no more than two degrees, Fahrenheit. Walls and roof of the room are fully insulated and all electrical conduits and light fixtures are moisture-proofed.

When the temperature in the curing room rises above 73 degrees, Fahrenheit (maximum permitted by American Society Testing Materials), the refrigerating unit pumps a refrigerant through the air-conditioning coils, thus cooling the air current as it passes into the room. When the minimum temperature (68 degrees) has been reached, the refrigerating unit automatically turns off and heaters turn on. The air current then circulating in the room is warmed. This cycle of alternate heating and cooling may be continuous. However, it has been found that in the



Air conditioned for concrete curing

warm summer weather the heaters can be dormant, and similarly the refrigerating unit can be switched off in cool weather. The humidity is maintained by water being atomized continuously through a small nozzle, thus creating a dense fog. The blower which circulates the warmed or cooled air and also diffuses the water vapor operates almost continuously.

WOODEN-WHEELED TRAILER

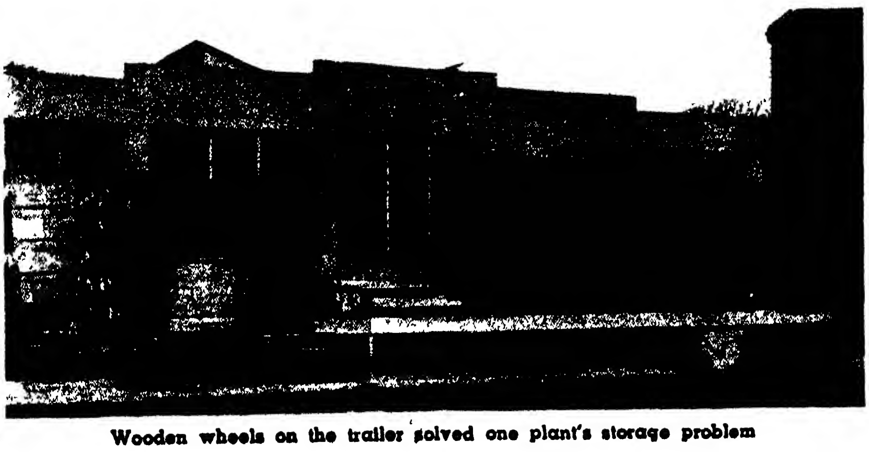
Improvised to Expedite Foundry Production

AN EXAMPLE of ingenuity in meeting today's production schedules was brought to light recently at a plant of The Cooper-Bessemer Corporation.

Faced with a problem of shortage in foundry floor area due to increased output, foundry workmen were cramped for space to store huge engine castings. To relieve this condition, some of the flasks and castings were placed on old flat cars and moved out of the foundry onto rail sidings for the necessary period of gradual cooling. When this expedient failed to solve the problem entirely, low flat platforms were constructed from scrap steel and discarded parts, and two heavy wooden wheels added to permit portability.

Now, castings weighing up to 16 tons are placed on these improvised trailers and moved about at will by simply coupling the trailer to one of the shop's electric-powered utility trucks.

The loaded trailers are usually parked in the yards outside the plant for cooling or for temporary storage. The same method is also used to save time in transporting the castings to and from the chipping and painting department located in a separate building.



Wooden wheels on the trailer solved one plant's storage problem

METALS IN INDUSTRY

(Continued from page 153)

which cannot be used if heated, during repair, to temperatures over 1300 degrees, Fahrenheit. Tungsten-carbide and high-speed steel tool tips are also being applied to ordinary steel shanks by silver-brazing, thus saving tons of critical tool alloys by confining their usage just to the tips of the tools.

The use of silver for brazing has grown the fastest of all silver applications during the war and will continue to expand in the post-war period, as will the use of silver-bearings and solders. These are all applications of silver involving more than just replacement of scarce materials—applications in which engineers are discovering that silver and its alloys have superior qualities of their own and can compete economically and technically with the more familiar industrial materials.

Other applications of silver that have post-war as well as wartime importance are its use, especially as a surface layer, for corrosion-resistant chemical process vessels and piping, its use for certain types of food or drug containers, its employment as a surfacing for permanent electrical connections (to defeat oxidation) and its application as a reflecting surface on head lamps, searchlights, flashlights, and so on. One of the largest industrial uses of silver—in photographic emulsions—is an old standby that will grow as photography does.

And, of course, sterling silver, silverplate for tableware (the Army and Navy are today using astonishing amounts of silver-plated steel eating utensils), coinage, and the use of silver for currency-backing will be with us in force as long as we have artistry, esthetics, meals, and governments. But this takes us back to the starting point of this article, which starting-point we suggest that the reader now re-read.

• • •

POWDER HARDNESS

Can Now be Measured on Single Metal Grains

QUALITY control of the production of many metals and metal products is exercised through hardness testing. With powder metallurgy parts (made by pressing and sintering metal powders), however, conventional hardness testing has been generally unsatisfactory because of the porosity or the duplex structure of such parts.

Recently devised is a "micro-hardness tester" that is able not only to measure the hardness of microscopic areas of such materials, but also to determine the hardness of individual powder particles. Ordinary hardness testers employ indentors that are considerably larger than individual grains and thus give an average reading of alternate particles and voids rather than the actual hardness of any single particle.

Essentially, the new instrument consists of a diamond penetrator (like that

used in the well-known Vickers hardness tester) mounted so that it can be attached to a microscope in place of the objective lens. The microscope has crosshairs in the eyepiece and, by properly alining the diamond, it can be made to touch the sample at a point directly in line with the crosshairs—in other words, right over any selected particle of powder, for example.

The pressure necessary to force the diamond penetrator into the grain of powder is furnished by a carefully calibrated spring. When an indentation is made, the diagonals of the diamond-shaped recess are measured by any one of several standard microscopic means, the indenting force represented by the spring is already known, and from these values a single calculation gives the micro-hardness of the particle.

With this instrument hardness measurements have been made directly on a single tungsten carbide particle for the first time, and the material was found to have a diamond pyramid (Vickers type) hardness number as high as 1850. Previous values, using ordinary instruments, had always been much lower because some of the softer cementing material was unavoidably tested along with the carbide.

Other data provided by the new tester show that annealed sponge-iron powder and annealed electrolytic iron powder have about the same hardness (about 50 diamond pyramid numbers).

The instrument is certain to be widely used to advance both the knowledge of hardness and the science and practice of powder metallurgy.

WELDING PROVED

Wire Production Serves as Accurate Index

An index of the expanding use of welding, aided by the war-effort impetus, is the production of welding wire (for filler-metal rods and electrodes) in 1942. Official data of the American Iron and Steel Institute reveal that 800,400,000 pounds of steel wire for welding was made last year—nearly double the 453,120,000 pounds for 1941 and more than three times the production in 1940.

Almost 13 pounds of welding wire were made in 1942 for each ton of finished steel produced. This compares with about seven pounds in 1941 and less than five pounds in 1938.

CAST DIES

Give Outstanding Performance in Shell Production

The old idea that all "cast iron" is a weak and brittle material has been dispelled by the use of specially-processed, high-strength iron castings for jobs where resistance to impact and other stresses is required.

Outstanding among examples of this is the just-revealed use, especially in Great Britain, of high-strength cast irons of the Meehanite type in the construction of cast-to-shape dies for forging shells and bombs. Some of the service requirements—for example, the horizontal nose-forging of three-inch shells at 2100 degrees, Fahrenheit—are extremely severe, yet the cast dies in the case mentioned have produced more than 6000 shells without failure.

A grade of alloy iron castings containing nickel, chromium, and molybdenum has out-performed forged-and-machined steel dies for this service in a dozen British installations, giving an average die-life of 18,000 shells, compared with an average of 11,000 for the steel dies.

THIN CASE-HARDENING

Accomplished by Use of Ultra-High Frequency Oscillators

Induction heating of metals has made tremendous strides in recent years, and much publicity has been given in recent months to the use of vacuum-tube oscillators with frequencies up to one million cycles for producing hardened cases 5 to 30 thousandths of an inch thin.

However, if the operating frequency is increased from one megacycle to four megacycles, the thickness of the induced-current carrying layer is reduced one half and the heat developed in this area is doubled. By applying frequencies of five to 15 megacycles to small parts, such as end bushings on a 0.63-inch hollow spindle of 0.35 percent carbon steel with 0.12-inch walls, for 7/10 of a second, ultra-thin (one thousandth of an inch), uniform, and very hard (Rockwell C 55) cases are produced.

The operation is self-quenching (no water-quench is required) since the mass of the cold part is relatively so much greater than the thin heated area in contact with it. The very short time at heat also fails to put all carbides in solution and the combination of hard martensite and carbide particles in a low-carbon steel surface may have interesting properties for special services.

GUNSTOCK FORMERS

Now Made of Steel; Last Much Longer

When walnut stocks for rifles are being produced they are made automatically on copying lathes. The roughed-out wooden blank is placed in a lathe with a metal facsimile and is automatically turned to the required shape by cutting tools which are guided by the metal former. Previously, these formers were made of iron and their life was relatively short.

Today, however, Winchester is making these formers of steel, the new formers having a life approximately 10 times that of the older iron type. The development which has made possible this improvement in gun stock manufacture is the Keller automatic die sinking machine. Heretofore no method had been available to shape satisfactorily this harder metal which is also more durable under production conditions as they are today.

New Products

WET-DRY BELT GRINDER

An abrasive belt grinder, recently announced, can be adjusted from vertical to horizontal position while it is running. The belt tension and tracking device can likewise be adjusted while running, by two conveniently located handles.

The Hammond "600" Wet-N-Dri machine illustrated is equipped with tank and pump unit and can also be equipped for water-main connection only. Both types are provided with damper or spray control and two nozzles for uniform spraying Should dry operation be desired at any time on either machine, it is necessary to merely turn off the water, remove drain connection and attach air exhaust system at this point.

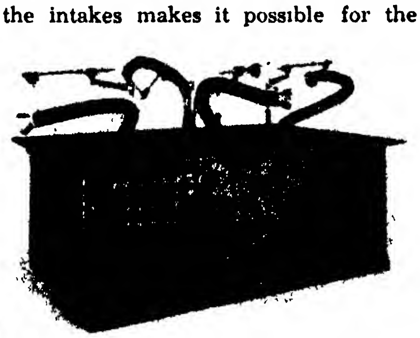
Belt grinder which can be adjusted from vertical to horizontal while running

Squaring, champfering, forming radii, grinding flat surfaces, rounding, polishing, and removing shaper marks are a few of the many present-day production operations being done on abrasive belt grinders.

DUST COLLECTOR

Designed for use with small portable grinders, a new work bench has been developed by Schmieg Industries which completely solves the dust problem inherent in this type of work.

The bench, as shown in the photograph, has four flexible hooded intakes. A motor-driven blower located under the bench top draws dust through the intakes, and discharges the air through filters. The flexible suction tubes of the intakes makes it possible for the operator to place the hood in any desired position so that the high-velocity suction may be concentrated at the dust source. Heavy dust particles settle out in a plenum chamber, while fine particles are removed by the replaceable filters.



Flexible hoods for four machines

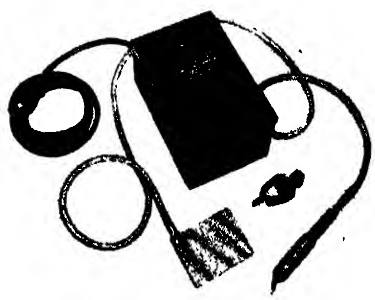
TRAMP-IRON DETECTOR

For general application on belt conveyors carrying non-magnetic materials, a new magnetic control has been developed to detect the presence of tramp iron. When such material, which might damage equipment or otherwise cause trouble, passes into the magnetic field set up by the detector, a relay is actuated to shut down the belt drive motor. When the tramp iron is removed the motor can be restarted. Operation of the magnets in these detector units, made by Dings Magnetic Separator Company, requires a source of constant voltage direct current.

ELECTRICAL MARKER

For placing freehand numbers, symbols, and identifications on soft or hardened steel, alloy steels, other ferrous alloys, wrought iron, and cast iron, a new unit consists of a special transformer with ten voltage stages controlled by a convenient rotary switch, a hand-held marking pencil, a ground plate for use with small work, and a ground clamp for large work. The voltage selection makes it possible to obtain any desired depth of marking, from the faintest line to the heaviest arc required for penetrating through scale or dirt on castings or heat-treated parts.

The marking point is made of a heat-resisting alloy and is threaded into the holder at an angle so that it stands vertical to the work when the holder is placed in normal writing position.



Hand-held marker for metals

Use of this device, made by the H. P Preis Engraving Machine Company eliminates the necessity for stamping parts before heat-treating them and is represented as a clean, fast, and economical marking method, requiring a minimum of cleaning and surface preparation.

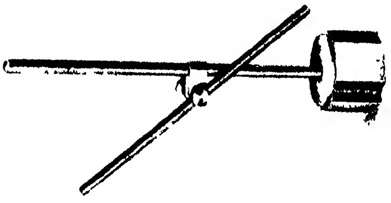
PLASTIC SYPHON

Designed for easy transfer of liquids from carboys, a new plastic syphon tube is equipped with valves which enable the syphon to remain primed as long as any liquid remains in the

carboy. The intake section of the tube is filled through a ball valve by the use of a hand operated pump. The discharge end of the syphon is controlled by operating another valve. This unit, called Safety Syphon, is available through the Central Scientific Company.

MAGNETIC ADAPTER

A PERMANENT-MAGNET clamping block that has wide applications in set-up and inspection layouts is shown in the accompanying illustration together with a standard and swivel arm. Known as the Windemere Magnetic Adapter, this unit can be used not only as indicator holder but as a general work-holding block for anchoring parallel angle iron



Magnetic block of many uses

and other work pieces in any given position The adapter weighs approximately 20 ounces and is furnished with an upright center post either 3/8 or 5/16 of an inch in diameter

WHEEL ADHESIVE

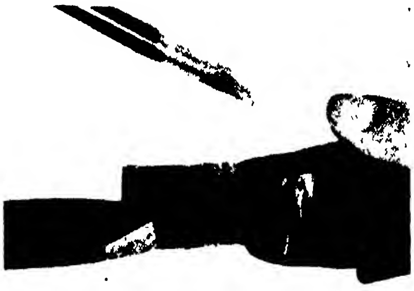
GREAT penetration, high bonding qualities, and long-wearing strength are qualities provided by Stikum, a new polishing wheel adhesive that does away with cooking and mixing operations. The grinding surface obtained with Stikum is reported to be more flexible than with either glue or cement, to resist friction heat, and to wear uniformly to the last grain

SUPER-STRENGTH BONDING

RUBBER, synthetic rubber, plastics, leather, or wood may now be united to metal or to each other with a bond stronger than the materials themselves, by means of a new process announced by The U. S Stoneware Company.

Already in use for vital war applications, the new method (known as the Reanite bonding process) holds promise of making possible metal-and-plywood panels to form light weight, fire-proof, water-proof structural assemblies for pre-fabricated housing units, boats, airplane or motor car assemblies, kitchen cabinets, refrigerators, furniture, and so on. Composite metal and plastic parts may be molded; rubber and metal spring assemblies for smooth, soft, quiet, and vibration-free riding are reasonable possibilities arising from this development

Application of the Reanite process is simple. The surfaces to be joined are brushed, sprayed, or dipped with Reanite After drying, mild heat and pressure is applied. The joint is said to be unaffected by fresh or salt water, is non-corrosive to metals, and pos-



A strong rubber-to-metal bond

sesses excellent corrosion-resistance in itself, as well as high dielectric strength

Repeated laboratory and field tests indicate that it requires a direct pull in excess of 30,000 pounds to separate two six inch square pieces of steel bonded with Reanite. On repeated tests of bonds formed between natural rubber, synthetic rubber, plastics, leather, and wood, the materials themselves gave way before the bond

ACID ETCHING

A NEW portable inspector's acid etching kit for indelibly marking metal production parts consists of an acid-proof housing, a bottle of acid, a bottle of neutralizing liquid, and a set of marking stamps made of an acid-resisting synthetic material.

Within the housing is a stamp pad saturated with the acid When this housing is tilted to uncover the pad the operator touches the desired stamp to the pad, withdraws it and then allows the cover to close so that acid fumes will not escape After the stamp is touched to the work to be marked a drop of neutralizing liquid is applied to prevent further etching

WOOD SEALER

SEALING materials for use in waterproofing wood crates and boxes are now available which not only seal the lumber itself, but cracks and joints as well. These materials, made by the Carbozite Corporation, come in two forms The surface sealer is a liquid which applies with a spray gun and dries in approximately 30 minutes. It is claimed to seal the natural moisture

into lumber, thus preventing drying, shrinking, and warping. The joint sealer is in mastic form and is applied with a trowel or pressure gun. It is claimed that the mastic will bond perfectly with the surface sealer and will remain pliable indefinitely.

BEARING WASHER

In the manufacture of many instruments and machines, the utmost care must be exercised to make sure that the bearings are absolutely clean before assembly. Realizing this, the en-

Washing machine, with door open

gineers of the Metal Washing Division of American Foundry Equipment Co., working with an important manufacturer of instruments, perfected a simple but highly efficient unit to clean bearings individually without exposing them to room air or handling which would result in rusting from finger smudges.

The bearing washer consists of a solvent container, a fractional horsepower solvent pump, a solvent filter, and the proper bearing adapters. If it is necessary on certain types of work to remove excess solvent from the cleaned bearings, an air hose connection providing clean filtered air can be built into the cleaning unit.

The solution is continuously recirculated and before reaching the nozzle, it passes through a filter to remove all minute dirt particles All parts of the machine are Parkerized to provide rust protection. An non-breakable plastic door is included to allow the operator to view all operations.

COUNTERSINK STOP

Based on the principle successfully used in engine valve-spring design, a split keeper which gives positive set to the retainer collar on bearings is now incorporated in micrometer stop countersinks manufactured by Aero Tool Company. With this positve locking feature, no amount of vibration

New micrometer countersink stop

will loosen the bearing retainer and cause damage to the tool or material, it is said.

The keeper insert works on the slotted, taper shaft principle All force is directed toward the shaft center under constant, even pressure.

Lightning-quick service is now possible with this added feature. The unit may be immediately disassembled by hand. No tools are required. On-the-job oiling and other required servicing becomes a matter of moments, thereby speeding operations.

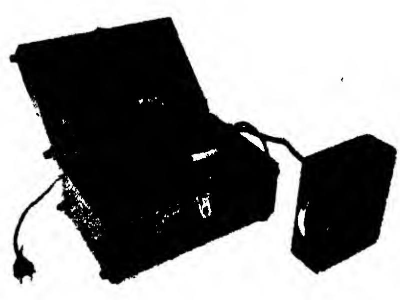
WATERPROOF CLOTH

An extremely thin, invisible, yet waterproof coating for such materials as cloth, paper, and ceramics may be obtained through the use of a new liquid known as Dri-Film. This liquid vaporizes at a temperature somewhat below that of boiling water and the vapor is used to form the waterproof coating. Application of the vapor is made in a closed cabinet.

GLOSS MEASUREMENT

Designed for measuring specular gloss of paints and varnishes, ceramics, paper, and machined or polished surfaces, a new photoelectric Glossmeter is particularly suited to register changes in specular gloss as a result of age, wear, abrasion, exposure to moisture, heat, light vapors, or sprays.

The Glossmeter comprises the instrument proper and the search unit



Glossmeter search unit is at right

which is connected to it by a flexible cable. The search unit may be placed on the sample to be tested, or the unit may be positioned with the opening pointing upwards so that the sample is placed on top of it. The search unit may, furthermore, be turned with the opening sideways for convenient measurement of vertical surfaces. The samples can be of any size and mav be measured in rapid succession. The instrument is portable and will be found valuable in the laboratory as well as in production control, in the field, and in test fence work.

The operation of the instrument is simple and convenient, and requires no training on the part of the user. The search unit is first standardized to give a reading of 92.5 for polished black glass. Then the search unit is placed on the sample, and the needle indicates directly the gloss in terms of an ideal, completely reflecting mirror as 1000.

Current Bulletin Briefs

Conducted by
K. M. CANAVAN

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

INDUSTRIAL AIR POWER is a 24-page comprehensive pamphlet describing and illustrating a large number of air operated devices now in use by American industry. *Mead Specialties Company, 15 South Market Street, Chicago 6, Illinois.—Gratis.*

CAN GLASS HELP YOU FILL WAR CONTRACTS? is a 16-page illustrated pamphlet describing some of the war activities of a glass manufacturer, with emphasis on those characteristics which make glass adaptable to a wide range of applications. *Libbey Glass Company, Toledo, Ohio.—Gratis.*

HOW TO TAKE CARE OF YOUR CLOTHES is a 30-page pamphlet which tells of the importance of the proper selection of clothing material and how best to prolong the life of such materials. *Dan River Mills, 40 Worth Street, New York 13, New York.—Gratis.*

AIR EXPRESS WALL CHART is an 11½ by 26 inch chart which gives specific information on shipping by air express — what can be shipped, how to secure priorities, weight and size limitations, and so on. *Railway Express Agency, Inc., 230 Park Avenue, New York, New York.—Gratis.*

TESTS OF RIVETED AND WELDED JOINTS IN LOW-ALLOY STRUCTURAL STEELS, by Wilson, Bruckner and McCrackin, Jr., is a 76-page bulletin reporting results of a recent investigation in this field. Bulletin Series No. 337, *Engineering Experiment Station, University of Illinois, Urbana, Illinois.—80 cents.*

WELDING POSITIONER is a 4-page folder describing and illustrating specialized equipment for speeding up welding operations. *Lyon-Raymond Corporation, 1207 Madison Street, Greene, New York.—Gratis.*

MEETING TODAY'S EMERGENCY is a 2-page circular describing modern designs in completely flexible wood partitions for office and industrial use. *Martin-Parry Corporation, York, Pennsylvania.—Gratis.*

CEMENTED CARBIDE DIE MANUAL is a 32-page booklet covering standard and special dies for drawing wire, bar, tubing, and sheet metal. *Carboloy Company, Inc., Detroit, Michigan.—Gratis.*

EBONOL is an 8-page pamphlet describing in detail a simple procedure for direct low-temperature blackening of various metals. The finishes are produced in the form of stable, adherent, hard oxides. Also available are four pamphlets giving operating instructions for the above processes. *The Enthone Company, 442 Elm Street, New Haven, Connecticut.—Gratis.*

CARE AND CONSERVATION OF BRUSHES is a booklet which gives reasons why proper care of paint, varnish, and lacquer brushes is imperative, together with suggestions for such care. *The Osborn Manufacturing Company, 5401 Hamilton Avenue, Cleveland, Ohio.—Gratis.*

PRIMER OF ELECTRONICS is a 4-page simplified introduction to the electron and to the principles which govern its use. *General Electric Company, Electronics Dept., 1 River Road, Schenectady, New York.—Gratis.*

VULCAN SERVICE TO YOU IN THE POST-WAR ECONOMY is a 24-page plastic bound booklet describing tool and machine design services which are available through an organization that is conscious of the needs of tomorrow as well as of today. *The Vulcan Tool Company, ?13 North Beckel Street, Dayton, Ohio.—Gratis.*

HOW TO USE DIAGRAMS IN RADIO SERVICING, by M. N. Beitman, is a small booklet intended to aid radio students and beginner service men. *Supreme Publications, 328 South Jefferson Street, Chicago, Illinois.—10 cents.*

INDUSTRIAL HEAD AND EYE PROTECTION is a 48-page catalog concerned with a wide range of goggles, respirators, various types of masks, face shields, machine guards, and so on. *Chicago Eye Shield Company, 2333 Warren Boulevard, Chicago, Illinois.—Gratis.*

FLOODS OF MARCH 1938 IN SOUTHERN CALIFORNIA (Geological Survey Water Supply Paper 844) is a 399-page, illustrated, paper-covered, technical-scientific study of this great flood and, because of its source, it should be authentic and dependable. *Superintendent of Documents, Washington, D C.—$1.25.*

HOW TO TEACH FIRE FIGHTING is a 16-page illustrated pamphlet which shows how to set up fire fighting demonstrations, how to conduct them, and what their value can be to industry. *Walter Kidde and Company, Inc., Belleville, New Jersey.—Gratis.*

HAND TOOLS is a 52-page illustrated booklet that gives simplified, down-to-earth hints on the use of all the common hand tools ranging from files and hammers to wrenches and vises. *General Motors Corporation, Broadway at 57th Street, New York. New York.—Gratis.*

NEW MAGIC IN WOOD is a 32-page booklet that illustrates and describes many of the things which industry is doing today, using wood as a basic raw material. *American Forest Products Industries, Inc., 16 East 48th Street, New York, New York.—Gratis.*

Telescoptics

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

BEATS any prism binocular, is the testimonial which Dr. Henry Paul, 119 North Broad Street, Norwich, N. Y., gives concerning the "richest-field" telescope, or "RFT", after making the one shown in Figure 1.

The richest-field telescope is a stubby, compact instrument usually used without a mounting—simply held in the arms—and it is designed to give magnificent views of the myriad Milky Way stars. No specialized type of telescope has equalled it in popularity since its descriptive data were published in "Amateur Telescope Making — Advanced" in 1937.

Paul says he weighed all factors and chose a 5" mirror aperture, with focal ratio 4, which hooks up just right in a 6" Micarta tube to give optimum portability, size, and so on. The 5" mirror was cut from a 6" Pyrex disk. The field of view covered is better than 2° in

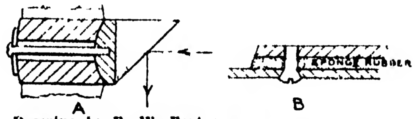
Figure 1: **Paul's RFT, arm-held type**

diameter. When the telescope is rested on the knee the eyepiece comes to just the right height for the eye.

Figure 2 shows detail of the diagonal support, which is easy to adjust. The two curves' locus is at center of the diagonal. The latter is an aluminized solid piece of Pyrex. The other sketch in Figure 2 shows how all adjustments for mirror and eyepiece are afforded: screws passing through sponge rubber.

After taking this telescope with him to the country and using it several nights, Paul writes, "The Milky Way was a bright ribbon all the way from horizon to horizon. I really got more of a thrill from the RFT than from my big telescopes. No complication: Just sit in a chair with a blanket around you and look to your heart's content."

ANOTHER satisfied "customer" for the richest-field telescope is Charles E Kratz, 3512 Dennlyn St., Baltimore, Md., whose 4" RFT of 16½" f.l. is shown in Figure 3. "I have had a big kick from the RFT," he writes, "and was surprised to discover how much can be seen with low powers."



Drawing by R. W. Porter

Figure 2: **Adjustments. Paul**

Kratz made the hex tube of ¼" mahogany, using hand tools, and glued it up.

The telescope sets on a home-made tripod, the head having three pieces of wood each set in so that the grain runs in the direction of the legs, with ⅛" mahogany glued on top and bottom.

The RFT has become so widely established as a telescope type since it was presented in "A.T.M.A." that the initials RFT have now become a word just as they stand, without periods.

MACHINE for grinding and polishing, shown in Figure 4 and made by Robert W. Coulter, 812 Sixteenth Street, N. E. Masillon, Ohio, "works like a charm," he states "with almost unlimited variations of stroke, and requires but little attention while operating." It is a modification of the Hindle type and was built on an old library table of heavy oak.

"Speed reduction was accomplished entirely with V-belts and pulleys. Speeds are: Drive 27; sidethrow, 5 1/2"; turntable 1 1/3"."

The machine as shown worked well on a 6" mirror but when a larger mirror was tried there proved to be whip due to the high extension of the vertical end shafts. When the shafts were shortened, after this photograph was taken, the whip no longer occured.

ABSTRACT of a correspondence file. Subject: Outsized mosaic tool for grinding mirror.

February 24, 1943. Coulter (the man named above) to this department. "I am contemplating a 12½" short focus mirror, and would like to make a tool of small glass caster cups mounted on a full-sized circular base, its surface shaped to convex spherical curvature roughly approximating desired sagitta for finished mirror. I propose to use one central cup surrounded by a ring of smaller cups, and this by a ring of larger ones—combinations of sizes and numbers that happen to suit my size of tool. Doubt has arisen, however, whether such a tool would produce a regular sphere on the mirror, or whether zones would result. What do you think?"

Reply, March 1, 1943: "Theoretically it won't work. This tool amounts to a tool made of annular, concentric rings. Stroking should minimize the effect but not get rid of it all. This is *theory* but theory often proves wrong. Theoretically, the Germans had the English licked. So try it, if you are willing to gamble, and after making the experiment please tell us the outcome."

Side comment by Cyril G. Wates, Edmonton, Alberta, to whom inquiry was shown: "What's the idea? Why not, instead, make a solid glass lap, bust it on a hydrant, and then glue it together again? In other words, why make such a lap at all? And what a job it would be to bring the irregular glass cups into contact!"

Reply by Coulter, on seeing above comment: "It's much cheaper than a solid tool, easier also to form the curve with a built-up tool than to work a solid tool to curve, and saves time Built-up tool also reduces suction when fine-grinding. (While working on a 12½" mirror a long-winded telephone interruption once led to my mirror and tool being welded together, and bad chips resulted from forcible separating.) But I suppose the underlying reason for the venture is to indulge a pet passion for oversized tools. [And it's always fun to try something different.—*Ed.*] Moreover, I like to be able to use long strokes throughout fine grinding—it goes much quicker and the mirror has to come to a sphere, since the two surfaces are always in contact Hence I propose an 18" tool for use with the 12½" mirror."

Final report by Coulter, June 22, 1943: "Caster cup tool seems OK. Shadow test of mirror showed evenly spaced, concentric zones—a target without a bull'seye—and turned up edge But these reduced readily with local

Figure 3: **RFT, tripod type. Kratz**

treatment by third finger dabbed in rouge. There also wasn't so much suction as with a solid tool. But Wates was right about establishing contact on a curved surface; it proved unsuccessful, so the tool was made flat, and it worked OK."

A reader of this department inquires. "Can a telescope mirror be made of cast aluminum? If so, where can I obtain aluminum blanks?" The answer is no, but the exact reasons make an informative discussion.

When an optical surface of glass is aluminized, the evaporated molecules, being in a high vacuum, travel, without bumping into other molecules, from the hot metal source to the mirror's cold surface and are deposited in a non-crystalline metallic film having the same degree of polish as that of the glass. As soon as air is admitted, the

Figure 4: Coulter's machine

metallic aluminum begins to oxidize and, according to Strong (*Astrophysical Journal*, June 1936, pages 401-423), this oxide continues to thicken for about 60 days. It is transparent and is either corundum (Al_2O_3) or bauxite ($Al_2O_3.2H_2O$). Dr. J. A. Anderson states in a private communication that "the layer of aluminum, approximately 1/250,000" in thickness, is made up of 250 molecular layers. Of these," he continues, "I would guess that within the first month's exposure to air about 20 to 40 layers will have turned into aluminum oxide. The light rays pass through the transparent oxide layer and enter part way into the metal, then turn around and go back again."

The above was shown to Dr. John Strong, who commented as follows: "If the thickness of one layer of aluminum is 4 angstrom units, or about $4 \times 10^{-4}\ \mu$, then 250 layers are about 0.1 μ (or 0.2 wavelengths of green light). The oxide coat is about 100 angstrom units in thickness."

An angstrom unit is a ten billionth of a meter. The Greek letter "μ" (mu) designates one micron, or 10,000 angstrom units A micron comes pretty close to 1/25,000 inch and a wavelength of green light is roughly 1/50,000 inch.

Hence the coat of aluminum, as originally laid down, is about 1/250,000" thick. After some 60 days about the outer 60/250, say ¼, of its thickness has turned into oxide of aluminum.

The actual mirror is therefore metallic the same as a silvered mirror, but we still haven't answered the question why all this couldn't be as easily—more easily, it might seem—accomplished simply by letting a disk of plain cast aluminum oxidize in the air in the ordinary manner (the thought in the question which opens this note—a question which others have asked.

Fred B. Ferson, a Biloxi, Mississippi, amateur telescope maker who has inquired into metals and casting metals (see his chapter on molding and casting, in "A.T.M.A."), states it thus· "Aluminum is a metal which absorbs gases readily, and is hard to prevent from taking up impurities when it is cast. Also in castings it cools into crystalline structure, the crystals coarse and full of holes—possibly from absorbed gases driven off."

J. H. White, 20 Burchfield Avenue, Cranford, N. J, a metallurgist and amateur telescope maker who built his own aluminizing equipment, when asked for his comment, added "Under the microscope the surface of an aluminum sheet, and still more an aluminum casting, shows a great many holes These are gas holes. There also are black specks which are hard and brittle and are aluminum oxide which it has been impossible to remove from the melt Even the best aluminum made by the Hoopes process, which has a purity of 99.983 percent, shows these spots. When the sheet is rolled the surface is smeared over and this covers up most of these defects. If a mirror were made of cast aluminum the crystalline structure of the metal, also the oxide particles, would show, and probably would fall out of the surface and leave holes."

Sometimes in popular writing (and some that isn't) it has been said that the oxide coating on an aluminized mirror is sapphire. This isn't literally true, though as a figure of speech it is a relative of the truth. The coating is aluminum oxide, Al_2O_3. If a given specimen of Al_2O is a crystalline mineral it is properly corundum Corundum has hexagonal crystals and its hardness is exceeded in nature only by that of the diamond; which, however, is very much harder If black, due to iron impurity, the corundum is emery. It may also be gray, blue, yellow, red, brown, or colorless If any of the last named crystals are clear and perfect—which is relatively very rare—the corundum is of gem quality. If blue, then it is sapphire; if red, ruby; if colorless, oriental white sapphire. That the coating on an aluminized mirror is protected by aluminum oxide is, therefore, the most nearly romantic (though not romantic at all) claim that can be made, for it isn't a gem and it isn't even crystalline.

Commenting on the above, Dr. Anderson notes an interesting analogy with quartz and fused quartz, the latter being the correct term for a "quartz" (often so-called) mirror· Quartz is a natural, crystalline mineral. Fused quartz is not crystalline, and neither, therefore, is a fused quartz mirror disk properly called quartz.

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with the names of available books, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for. Books listed in these columns may be ordered from our Book Department. Add 25 cents per book for mailing outside U. S.

Conducted by JOHN P. CANDIA

AMERICA'S GREATEST INVENTORS

By John C. Patterson

BIOGRAPHICAL sketches of 18 American inventors, living and dead, selected by a distinguished committee of scientists and industrialists as America's greatest inventors. These men have had tremendous influence on industry; an understanding of their trials and tribulations leads toward a better understand of industrial operations in general. (240 pages, 5½ by 8½ inches, a few drawings.)—$2.10 postpaid.—*A.P.P*

FUNDAMENTALS OF ELECTRICITY

By A Staff of Electrical Experts

THE War Department's recommended outline has been followed in the preparation of this text book in the basics of electricity. Although designed to supply men about to enter military service with a foundation for further training, the text will serve a similar purpose for anyone desirous of acquiring such knowledge. (388 pages, 6 by 8½ inches, a large number of drawings and photographs, plus a dictionary of electrical terms)—$2.10 postpaid —*J P C.*

MAPS AND SURVEY

By Arthur R. Hinks

DETAILS of how maps are made, covering early maps, the modern map, British official maps (the book is British), international maps, maps of Europe, other foreign maps, charts and atlases; also exploratory, trigonmetrical, property, geodetic, and photographic surveys; and survey instruments. (301 pages, 5½ by 8½ inches, 28 plates.)—$3.85 postpaid.—*A.G.I.*

SMOKE STREAMS

By Charles Townsend Ludington

MOST Americans understand mechanical appliances and movements easily and instinctively; the motion of water and waves with almost equal readiness. But while the air is all-pervading, it is invisible and mysterious and we cannot visualize its flow past airplane wing, yacht sail, or roof top. Mr. Ludington and an associate, Roger Griswold, working in the quiet of the country, burned dried leaves or wood, created a small, inexpensive, home-made tunnel by drawing smoke with a blower past the aerodynamic body to be investigated. The book, an outcome of these experiments in visualization, presents fascinating pictures. There pass in review flow pictures of airfoils, cylinders, roofs, flaps, slots, tips of wings, and dozens of other phenomena. Coupled with the pictures, there is a simple, readable, elementary, but accurate explanation of the phenomena. The whole is fascinating and instructive for laymen and professional. (144 pages)—$2 85 postpaid —*A K.*

WHY MEN CAN FLY

By M. K. Chapin

THE answer to the implied question in the title of this volume is: Because he thinks. However, thinking alone can never result directly in flight. It is the product of human thought translated into aero-dynamics that has made possible aviation as we know it today. These thought processes are logically and simply traced in the pages of this volume which brings the reader up to date in aviation—and into the future—with a minimum of study. Not a text book, but an easily read exposition on the subject. (388 pages, 6 by 9 inches, a number of drawings.)—$2.60 postpaid.—*A.P.P.*

THE WAR ON CANCER

By Edward Podolsky, M.D.

WHAT the layman should know about cancer: How it is detected; treatments; food and cancer; cancer research (179 pages, 5 by 7¼ inches, 2 illustrations.)—$1.85 postpaid.—*A.G.I.*

AERIAL PHOTOGRAPHS AND THEIR APPLICATIONS

By H. T. U. Smith

AERIAL photography has far greater applications than those pertaining to military matters. It is of value in economic geology, in many engineering fiellds,

in forestry and agriculture, in city planning, and in archeology. With a special eye toward these uses, the text of the present book is built up through the taking and study of aerial photographs to various methods of interpretation. (372 pages, 6½ by 9½ inches, 62 photographic plates and over 50 drawings.)—$3.85 postpaid.—*A.P.P.*

AERIAL PHOTOGRAPHS: THEIR USE AND INTERPRETATION

By A. J. Eardley

PRACTICAL guide for geological students and others having some technical background. All applications of aerial photography are carefully considered and the military importance is also stressed but the emphasis is mainly on structural geology. (203 pages, 6 by 9 inches, 9[illegible] illustrations.)—$2.85 postpaid.—*A.G.I*

AERODYNAMICS FOR MODEL AIRCRAFT

By Avrum Zier

WHAT makes airplanes fly is the general theme of this book, presented in non-technical language. Many of the data are based on wind tunnel tests with model planes. (260 pages, 6 by 9 inches, 107 drawings.)——$3.10 postpaid. —*J.P.C*

THE AIRPLANE AND ITS COMPONENTS

By W. R. Sears

AN INTRODUCTION to the field of aeronautical engineering prepared for students or other persons having some technical knowledge, technical terms are, therefore, employed with little or no definition. Parts of the airplane are considered and discussed in relation to their relative importance to airplane design, rather than by part sequence or general availability. Not a popular book, but rather one which requires concentrated study ([illegible]5 pages, 6½ by 9½ inches, a number of drawings and photographs.)—$1 35 postpaid.—*A.P P.*

UNLOCKING ADVENTURE

By Charles Courtney

IN THIS autobiography of a world-famous locksmith, the safes of Kaiser Wilhelm, locks in the Kremlin, chests containing the crown jewels of the Romanoffs, and safes of wrecked ships are factors in but a few of the adventures of the world's highest paid legal Jimmy Valentine. (335 pages, 5¾ by 8½ inches, illustrated)—$2.60 postpaid.—*K.M.C.*

WESTWARD FROM VINLAND

By Hjalmar R. Holand

COMPLETE account of the much-debated Kensington Stone found in Minnesota and inscribed in 1362 by Norsemen who were trying to circumnavigate Vinland by way of Hudson Bay. Today a majority of quoted authorities favor the validity of the author's long-fought-for claims. In addition to the Stone's inscription, three attested 14th Century Norse battle-axes

The Editors Recommend

Best Sellers in Science

PLASTICS — *By J. H. Dubois.* Meaty information on the whole general subject of plastics, presented in narrative form for easy reading. Tabulations of properties of plastics, plus basic design information, for laymen and technicians alike. $3.10

EXPERIMENTAL ELECTRONICS — *By Ralph H. Muller, R. L. Garman, and M. E. Droz.* A solid book of eminently practical information on the characteristics and non-communication applications of electron tubes. The text describes experiments and presents results. For students, radio engineers, communications experts, and the serious general reader. $4.75

HOW TO READ ELECTRICAL BLUEPRINTS — *By Gilbert M. Heine and Carl H. Dunlap.* A chapter on how blueprints are made, plus nine other sections, each of which is devoted to a specialized part of the electrical field, from bell and signal wiring through motor control diagrams to power station blueprints. $3.10

GET TOUGH! — *By Capt. W. E. Fairbairn.* How-to-win-in-hand-to-hand-fighting directions, by a man who really knows rough-and-tumble methods that are *not* "clean" fighting but *are* designed to win. $1.10

FUNDAMENTALS OF PERSPECTIVE — *By Theodore DePostels.* Colored drawings are used to show the sequence in which lines are to be drawn in order to obtain correct perspective. This material is presented in binder form with 20 illustrative sheets. $2.60

LEARNING TO NAVIGATE — *By Weems and Eberle.* For those totally inexperienced or only casually familiar with the fundamentals of navigation, this text will provide a practical handbook leading to an understanding of navigation at sea or in the air. A number of illustrations and tabulations $2.10

FUNDAMENTALS OF RADIO — *By Jordan, Osterbrock, Pumphery, and Smeby.* With this one volume alone, and with some diligence of application, it is possible to obtain a thorough grounding in radio principles. In thoroughness of treatment, with due respect for the needs of the reader, this book is outstanding. $5.10

POPULAR MATHEMATICS—*By Denning Miller.* Anodyne for those who have mathematical indigestion Ground treated is arithmetic, geometry, algebra, analytical geometry, trigonometry, conic sections, solid geometry spherical trigonometry, calculus. The coverage is not complete; it is rather, a collateral book—and good friend. $3.85

ELEMENTS OF ORDNANCE — A textbook prepared for cadets of the United States Military Academy. Covers manufacture, the chemistry of explosives, types of weapons, mathematics of ballistics, etc. $6.60

AIRCRAFT INSTRUMENTS — *By George Ellis Irvin.* All types of instruments for aircraft use described for students, pilots, inspectors. Fundamentals, instructions. $5.10

MARINE DIESEL HANDBOOK — *By Louis R. Ford, M.A.* A compendium [illegible] on design, construction, and operation of the marine Diesel engine with chapters covering applications, principles, types, fuel injection systems, lubrication, supercharging, and so on. $7.25

MACHINERY'S HANDBOOK—*Eleventh Edition.* "Bible of the mechanical industry," enlarged to 1815 pages of latest standards, data, and information required daily in the shop and drafting room. $6.10

PROCEDURES IN EXPERIMENTAL PHYSICS — *By John Strong, Ph.D.* A wealth of useful data of a practical kind for the constructor, experimenter, and skilled craftsman. $6.80

STEEL SQUARE POCKET BOOK — *By Dwight L. Stoddard.* Practical methods of using the carpenter's steel square for layout work of all kinds. Time tried methods used by two generations of carpenters and found both rapid and accurate. $1.00

REFINING PRECIOUS METAL WASTES — *By C. M. Hoke.* A practical book, based on experience, dealing with processing, identification, and repurification of such metals as gold, platinum, silver, alloys, iridium, and rhodium. $5.10

WORKING WITH THE MICROSCOPE — *By Julian D. Corrington.* For the serious beginner. Explicit, practical. $3.60

TOOL MAKING — *By C. B. Cole.* Instructions for making and using all kinds, from personal tools to arbor presses, lathes, planers, etc., in different metals $3.60

THE ELECTRON MICROSCOPE — *By Burton and Kohl.* A well-written account of this newest tool of science, with all technicalities explained for complete understanding by average persons. $3.95

ENCYCLOPEDIA OF KNOTS AND FANCY ROPE WORK — *By Granmont and Hensel.* More knots are described in this remarkable book than in any book on seamanship ever published or dreamed of. 3257 knots are illustrated in half-tone reproduction and are described in the text. $5.10

A MATHEMATICS REFRESHER — *By A. Hooper.* Prepared mainly to refresh aviation trainees whose high school mathematics is rusty. Scope arithmetic through calculus. $2.60

PLASTICS, PROBLEMS AND PROCESSES — *By Mansperger and Pepper.* The whole story of plastics, including a resume of manufacturing processes and a number of thorough-going chapters devoted to plastic uses. $3.10

AUTOMATIC ARMS — *By Melvin M. Johnson and Charles T. Haven.* Comprehensively covers machine guns, machine rifles, sub-machine guns, pocket pistols, shotguns, sporting, military rifles in automatic classification $5.10

MIRACLES OF MILITARY MEDICINE — *By Albert Q. Maisel.* The drugs, devices, and techniques used in the services. $2.85

HANDBOOK OF CHEMISTRY AND PHYSICS — A classic reference book recently revised and brought up-to-date to keep pace with recent research. Includes material on all branches of chemistry, physics, and allied sciences. Used in laboratories and by engineers throughout the country. Flexible binding 2503 pages. $4.10 Foreign $4.50, postpaid

ATOMIC ARTILLERY — *By John Kellock Robertson.* Electrons, protons, positrons, photons, neutrons, and cosmic rays, all described for the layman in plain language. Also transmutation of the elements and the manufacture of artificial radio activity. $2.35

The above prices are postpaid in the United States. Add, on foreign orders, 25¢ for postage on each book, except as noted.

For Sale by: October, 1943

SCIENTIFIC AMERICAN, 24 West 40th Street, New York 18, N. Y.

I enclose $... for which please forward at once the following books:

....

....

Name ....

Address ....

Write us for information on books on any subject We can supply any book in print.

and other supporting artifacts have been found in Minnesota. This book is a well-tempered, objective presentation of the whole fascinating subject by the Stone's chief exponent. Evidences accumulate to add weight to the growing realization that the Norsemen were in America much more often before Columbus than has until recent years been believed. (354 pages, 5½ by 8½ inches, 50 illustrations.)—$4.10 postpaid.—*A.G.I.*

VISIBILITY UNLIMITED

By Ernest G. Vetter

Two books in one—an elementary though fairly complete treatise on the essentials of the art of practical flying, which explains thoroughly how to use navigation computers and all the vital navigation instruments, also radio equipment. An attractively illustrated volume, well printed and suitable for others than aviators; in fact, even a youth (of the bookwormish type) would find it good going. (352 pages, 6 by 8¾ inches, copiously illustrated)—$4 10 postpaid.—*J.P.C.*

TIME, THE REFRESHING RIVER

By Joseph Needham

Philosophical essays, 1932 to 1942, and addresses of the noted Cambridge University brochemist who prowls far afield from his vocation into ethics, religion, sociology, and all else (280 pages, 5½ by 8½ inches, unillustrated.)—$3.85 postpaid.—*A.G.I.*

FIRST PRINCIPLES OF RADIO COMMUNICATIONS

By Alfred P. Morgan

From static and current electricity to magnetism, conductors and insulators, fundamental direct current calculations, transformers and condensers, electron-tubes and other radio component parts, the text leads the reader in an easily understood manner through all of those phases of reading necessary to an understanding of the fundamentals. (366 pages, 6 by 9 inches, thoroughly illustrated and indexed.)—$3.10 postpaid.—*A.P.P.*

GREENLAND

By Vilhjalmur Stefansson

As a stepping stone to the Norse discovery of and several expeditions to America (in addition to the commonly known one by Leif Ericsson) Greenland figures importantly in the adventurous account of the fearless enterprising pre-Columbian Norsemen. The noted arctic authority here brings together the whole long saga—discovery by the Irish, then by the Icelanders; the Greenlanders' later discovery of America; the 500-year occupation of Greenland and the final tragic disappearance of the forgotten colony; also the modern exploration and resettlement and Greenland's strategic significance in World War II. (338 pages, 5¾ by 8¼ inches, 18 illustrations.)—$3.50 postpaid.—*A.G.I.*

Printed in the U S A Press of the Wilson H. Lee Company, Orange, Connecticut.

18994

Scientific American

Founded 1845

CONTENTS • NOVEMBER 1943

COVER: In the airborne-type torpedoes, shown in our front cover illustration, there are 75 different pressed metal parts, totaling several hundred pieces, in each. (See also article dealing with methods of producing pressed metals, starting on page 208.) The photograph was taken in one of the plants of the American Can Company where these "tin-fish" are being turned out under mass production conditions. The torpedoes are shown, ready for shipment, minus their explosive war heads, which are shipped and loaded separately.

SCIENTIFIC AMERICAN, November, 1943 Vol 169, No 5 Owned and published by Munn & Co., Inc., Orson D. Munn, President; I Sheldon Tilney, Vice-President; John P. Davis, Secretary-Treasurer; A. P Peck, Assistant Secretary, all at 24 West 40th Street, New York 18, N. Y Entered at the New York, New York, Post Office as second class matter June 28, 1879, under the act of March 3, 1879. Additional entry at Orange, Connecticut. Published monthly by Munn & Co , Inc , 24 West 40th Street, New York 18, N. Y Files in all large libraries; articles are indexed in all leading indices Subscription rate $4.00 per year. Canada and foreign $5.00

Previews of the Industrial Horizon

A. P. Peck

INDUSTRY'S JOB TOMORROW

ADDED emphasis to the now wide-spread realization that industry's future as the guiding force of the American way of life depends on how well it plans for the days immediately following the end of the war is given by a governmental report recently released by the Labor Department's Bureau of Statistics. In this well documented report, where main emphasis is placed upon employment in post-war times, a statement is made to the effect that industry's part will call for real courage and intelligence.

Surely industry in general has shown "real courage and intelligence" in the race of production, in adapting itself, its men and materials, to a gigantic war program such as has never before been faced in history. It has shown its ability to develop and use new ideas, new methods, new products, and to do this with a speed that has today succeeded in making much brighter the picture of the war's progress.

If, when post-war times arrive, the same initiative is applied to building a new and better world on the basis of past failures and successes, there can be no question of the outcome. But this initiative can be applied only if the attitude of government toward industry is one which shows plainly and without reservation a belief in the honesty of private enterprise. Without such belief, industry's efforts will be severely handicapped.

MORE ABOUT RECONVERSION

ONE OF the dangers of words is that they sometimes are too limited in scope. Much is being said these days about reconversion of industry; "reconversion" is one of those limited words. Strictly speaking, reconversion would indicate aiming at pre-war levels of production when the whole thinking trend of the present should be in terms of post-war expansion.

On the horizon are days when a pent-up flood of buying will be released, when savings of millions will be poured into markets now closed by war-production requirements, when men now in the armed forces will be readjusting themselves to civilian life. Such days call for a raising of industry's sights, for post-war planning that is much more than mere reconversion, for production in many fields on a scale that before the war would have been in the realm of the unthinkable.

When this great expansion period starts, it is safe to predict that industry will be well on the way to keep its faith with the people of the world. The contributions of science and technology will be available for civilian use and will be turned into the channels of trade just as rapidly as possible, subject only to such possible handicaps as are mentioned in the preceding item

CONSERVATIVE THINKING

LEST SOME of the foregoing be interpreted as meaning that the day after the end of the war will see production start on helicopters and airplanes for every garage, high-octane gas in every filling station, fantastic automobiles that glide along the highways at a hundred miles an hour, robot kitchens where a turn of a knob will cook a ten-course meal and then wash the dishes without human intervention, and other similar dreams so dear to the heart of the Sunday supplements, a few words of conservatism should be added to the views expressed.

Reconversion and expansion must go hand in hand. Industry must plan its operations so that it can, with the least possible delay, start civilian production. This will mean that many of the things obtainable before the war and not available now will be the first to reappear in the markets. Then, but gradually, will come the new products—the new automobiles, the airplanes, the home comforts, the new building materials, the hundred-and-one other looked-for developments.

Viewed as a whole, the picture on the horizon is a composite one in which the production of the old and the new will progress side by side, supplementing each other and welding themselves firmly into the necessary expansion program which will spell economic security assured by industrial and technological coördination.

LIGHTER THAN AIR

WILL some part of the air-borne cargo of the future be carried in lighter-than-air ships similar to the ill-fated *Hindenburg* of a few years ago, or even greater in size and capacity? Some basis for an affirmative answer to this question is to be found in the successful use of blimps by the United States Navy during the present war. These ships of the air have been highly successful in the work to which they have been put, carrying out their missions in fair weather and foul, often under conditions when heavier-than-air ships were grounded.

The *Hindenburg*, it will be remembered, was a victim of inflammable hydrogen; helium, it will likewise be remembered, is available in commercial amounts only in the United States and is the lifting gas that spells safety for airships.

With our supplies of helium and with the knowledge that has been gained through the construction and operation of many Goodyear blimps during the past two years, it is entirely conceivable that large, rigid airships will someday become an integral part of our air transport system. Slower than planes, unwieldly though they appear, they have advantages over the swifter craft in payload and in the fact that they do not depend upon their motion through the air for lifting power.

Dirigibles have military uses as well as commercial, and it is entirely possible that we may yet see, during this war, the launching of one or more giants of the air. If this comes to pass, keep an eye on lighter-than-air development for passenger and cargo transportation in the future.

HEAVIER THAN AIR

BEFORE leaving the subject of aerial travel for this month, reference should be made to the article on future private planes, page 199 of this issue Last month's Horizon Preview of this subject sounded a note of conservatism that still stands, yet becomes even more thought-provoking in light of Dr. Klemin's thorough analysis of the present and of the possible future. Without doubt, the aviation industry is going to do all in its power to make reasonably priced planes, with a maximum of safety, available to all those who would fly the skyways of the world

THE SERVANT IN A WIRE

RADIANT heat lamps for home heating, increased use of fluorescent lamps for better seeing, plant growth stimulated by artificial light, improved electric home appliances — these are some of the things to come that will make for tremendously increased demands for electric power in the future So states Samuel G. Hibben, director of applied lighting at Westinghouse Basing his statements on war-time uses of

(Please turn to page 231)

50 Years Ago in . . .

(Condensed from Issues of November, 1893)

UNIVERSAL LANGUAGE — "Attempts to introduce artificial languages are not only hopeless, but they are unnecessary, for, says Dr. Schroer, there is already a universal language, and that is English. But in what sense is English a universal language? It is, says Dr. Schroer . . . in the Preussische Jahrbuecher . . . one, which, by its spread over the whole earth and by the ease with which it may be learned, has reached a position so far in advance of all others that neither natural nor artificial means can deprive it of its assured position as the future means of international intercourse. He therefore concludes that 'the English language is the world-speech, and will, to all appearance, become more and more so every year.' "

BRAKES — "A Rochester man has devised a plan by which a trolley street car can be stopped almost instantaneously, or within a space of three feet, while the car is going at full speed. As he omits, however . . . to provide for stopping the passengers, it is only fair to presume they will object."

STORAGE BATTERY — "Recently the [Plante storage battery] system was introduced into this country by the Edison Illuminating Company, at the 53rd Street central station,

Storage battery plant of the Edison Illuminating Company

where it is daily used to help out the dynamos when the demand for current is very great. It is also used for supplying current when the engines and dynamos are at rest. The charging is done when the dynamos would otherwise be running with a light load. This station is provided with two batteries, each consisting of a series of 70 cells of 61 plates each . . . Each cell has a capacity of 1,000 ampere hours."

ARTIFICIAL DIAMONDS — "At the Academy of Sciences, M. Moissan announced recently that, in continuing his researches on the synthesis of the diamond by means of the electric furnace, he has just obtained two compounds well worthy of attention. These bodies are silicide of carbon and boride of carbon. They are of exccessive hardness, and cut rubies, steel or diamonds."

TELESCOPE — "A great refractor is just finished and placed in position for Dr. Janssen at Meudon. It is a combined photographic and visual telescope. The two lenses were made by the celebrated Henry Brothers, of the Paris Observatory. The mounting is by Gauthier, of Paris. Both lenses will be mounted in the same tube, which is square and of steel. The visual objective is 82 cm. (32.3 English inches) in diameter, while the photographic objective is 63 cm. (24.8 English inches) diameter. Both lenses are of the same focal length, 17 meters (669 English inches) . . . The dome is to be moved by a gas engine of 12 horse power."

CIRCLE OF CONFUSION — "If any point in an object is represented by a disk about 1/100 of an inch in diameter, it is sharp to the eye. If, therefore, all movement of the object can in the image be confined to this amount, it will appear sharp. Now, with a hand camera, the focus of the lens is usually about 5½ inches—let us say 6 inches. At 50 feet off, therefore, an object may move through 1 inch and still appear sharp—that is, the motion during the time of exposure may be that amount."

FROZEN FISH — "Science has conquered nature and has demonstrated that to preserve fish it is not necessary to salt them. Freezing is the thing in the future, and Sandusky, Ohio, is the place where the first attempt has been made to carry on the business in a general way . . . About three years ago A. J. Stoll, a fish commission dealer in Sandusky, began to experiment with freezing fish, and soon found that the invention of the ice-making machine would be his salvation. Last year he completed his scheme and now he has a plant in full operation, employing twenty-five men and a capacity for freezing and preserving twenty tons of fresh fish each year."

ALUMINUM — "The Aluminum-Industrie-Actien-Gesellschaft, of Neuhausen, in Switzerland, owing to the increase of its dynamo capacity to 4,000 horse power, and some improvements in the processes employed enabling it to increase largely the production of aluminum, announces that the price from January next will be 45 cents per pound . . . At present, 75 cents a pound is the ruling price for aluminum."

COPPER — "At the time of the discovery of America, copper was used by the North American Indians only as a precious metal and for ornamental purposes, and had not reached the stage of industrial use, as it had among the Aztecs in Mexico. There is, moreover no evidence to show that the Northern Indians had any knowledge of ore working or smelting, and it is almost certain that all the copper they possessed was found in the metallic or native state."

LONG DISTANCE — "The American Telephone and Telegraph Company recently gave an exhibition of their long-distance telephone lines to a small party of guests who assembled at the Telephone Building in Cortandt Street . . A number of receivers were arranged so as to give each party a connection to the line. Connection was made with Boston, Chicago, and Washington in turn, and conversations were held with the officers at those points."

SOAP — "Washing powders or soap powders, which have latterly become important artices of commerce, always contain sodium carbonate, generally in the form of dried soda crystals."

WILLOWS — "A new industry has been established in St. Louis county near the little town of Allenton . . . which, if successful, will furnish employment to thousands of unemployed laborers. The enterprise is for the cultivation, on a large scale, of willows suitable for the manufacture of willow ware . . . The willow plants last about twelve years, after which they are grubbed up and the ground replanted. The plant does not attain its full growth until the second year, as the greatest part of its energy is spent the first year in making roots."

OIL VERSUS COAL — "Mr. Stone Burbury, of Cowes, Isle of Wight, owner of the yacht Venture, which was fitted with steam machinery, had this removed and replaced with an oil engine, made by Messrs. Vosper & Co., of Portsmouth. The vessel would not before steam against the strong tides in the Solent, but does so now with ease; she could also only conveniently carry sufficient coal for six hours, but is now fitted for running forty-eight hours."

"Quotes . . ."

"IN FUTURE years, we will do even better [in the field of air transportation]. The war has been a bitter laboratory for air transport but a laboratory none the less. Wartime research and inventions will be reflected not only in improved passenger transportation but also in faster air mail schedules and in lower cost cargo transport." *Juan T Trippe, President, Pan American Airways Corporation.*

" " "

"RESEARCH is seldom wasted, and few developments are ever valueless. It is true that today the electrical manufacturing industries are concentrating on the rather grim articles of defense. But we never lose sight of the fact that any new improvements we make in our equipment can and will be applied to the products of peace." M. W. Smith Vice President in Charge of Engineering, Westinghouse Electric and Manufacturing Company.

" " "

"POST-WAR planning is going on. It seems to me that this planning is in two categories. If I may be permitted to use an aerodynamic phrase, some of it is in the stratosphere. On the other hand we have sea-level planning. To my mind, one is the planning of spenders and the other is the planning of producers." *Alfred P. Sloan, Jr., Chairman of the Board, General Motors Corporation.*

" " "

"A PILOT on the South American Africa run recently flew the Atlantic four times within three days. Another pilot recently crossed the ocean twelve times in thirteen days, making one round-trip in less than twenty-four hours." Office of War Information

" " "

"THE [POST-WAR] pressure created by either too much unemployment or by too much government may mean that regimentation will displace free enterprise; that our free society will give way to some form of State socialism." *Paul G. Hoffman, President of the Studebaker Corporation.*

" " "

"WE ARE producing synthetic in the same quantity as we were getting natural rubber in a normal year before the war. We will soon be producing synthetic in about the same quantity that the entire United Nations group was using natural rubber before the war." P. W. Litchfield, Chairman of Goodyear Tire and Rubber Company.

" "

"IN CONTRAST to ships, planes, and tanks, the production of military explosives since the beginning of the war has always been as much as the Army and Navy could ship, load, and fire." *Charles A. Higgins, President of Hercules Powder Company.*

AVIATION

Conducted by ALEXANDER KLEMIN

As the artist sees the proposed Stout Aerocar, described in the text. At the left is shown the double-duty airplane and automobile, as it will look in flight. At right, wings and tail are being lowered onto the "body"

Post-War Private Planes

The Aviation Industry is Basing Plans for the Future Largely on Pre-War Models, Plus Knowledge Gleaned from War-Time Production and Operation. Will the Post-War Private Plane Follow Conventional Lines or Will it be a Radical Departure From Present Forms?

NEWSPAPERS and magazines of today abound with references to private flying of the post-war future and frequently predict an airplane in every garage. And while the end of the war is not yet in sight, and private-plane manufacturers are co-operating to the fullest extent in building training planes or parts for combat aircraft, they are all thinking of the "family" airplane which they hope to be building soon. No one can foresee the exact future of private flying, but the following established factors tend to optimism. The tremendous achievements of the airplane in war; the large number of war-time pilots who will return to civilian life with an interest in flying; the millions of people who have become aviation-minded by virtue of their war-time labors; and the improvements in the airplane itself and in methods of production

On the whole, we can look forward with confidence to an expansion of civil aviation after the war. We can be certain of only one thing, however: Pre-war flying was mainly a hobby or a sport; after the war there will be more flying of the family type, with a purpose not unlike that of the family automobile. Therefore the buying public will quite reasonably demand more speed, increased safety, greater strength, extended range, and more comfort.

The small airplanes of today (or rather of yesterday) were good craft and it is sad to examine circulars and see them marked "Not now in production." Naturally, their makers today are building military trainers, gliders, or parts. The automobile industry appears to expect that its first post-war models will be quite similar to those it scrapped soon after Pearl Harbor. Perhaps the airplane "flivver" of 1942 will also be the type first offered to the public in post-war days. At any rate, it is interesting and perhaps prophetic to note details of some of these fine little ships, as well as of some of the small planes which are doing outstanding military work today.

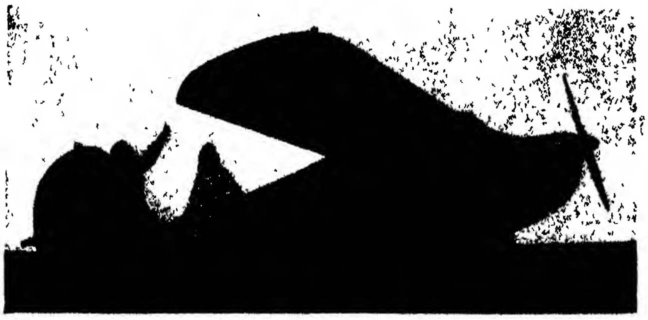
The Aeronca Super Chief, for example, is a closed-cabin two-seater, of the high-wing type, trim and neat in appearance, with fine visibility through its rounded plastic windshield. This ship has a gross weight of 1250 pounds and a wing loading of only 7.4 pounds per square foot. It is powered with a 65-horsepower Lycoming or Continental four-cylinder engine, has a top speed of 109 miles an hour, and cruises at 100 miles per hour. Its range is 500 miles. The photograph of the cabin indicates that even our small pre-war airplanes are comfortable and well equipped, with plastic instrument board, and handy, small control wheels. Doors swing wide, and everything looks comfortable though a trifle compact.

The Taylorcraft L-2, which Taylorcraft Aviation Corporation believes it will build after the war, is an adaptation of the tandem trainer used so widely in the Civilian Pilot Training Program. In the military version there is extension of the windshield and window area to enlarge the field of vision The observer's seat in the rear is full swiveling. Equipped with two-way radio, the observer can keep in communication with ground forces. particularly the artillery Here is a hint that even the small plane can carry two-way radio for civilian use. The L-2 has given fine service in restricted terrain in military maneuvers, which is also a hopeful indication for the future.

The photograph of the Luscombe Silvaire gives the proof that a small, trim, two-seater can be built entirely in metal, and be equipped with trimmer tabs and other appurtenances which have proved so valuable to the air-liner and the military machine.

The Piper Trainer of Piper Aircraft has some interesting features. This is a machine which has evolved from the conventional two-seater light plane into a training plane with a canopy to give wide vision, and with a low wing of the cantilever type to replace the braced high-wing monoplane. With slotted flaps and retractable landing gear, and 130 horsepower in a bigger engine, the Piper Trainer can fly at 150 miles an hour and has a range of 700 miles.

Plane manufacturers are naturally somewhat reticent on the subject of expected post-war performance. Of course, when the war is over, the full industrial co-operation of today will be replaced by healthy competition. There is a fair unanimity of opinion, however, in regard to speed in the future. The public will probably never be satisfied with a top speed of only 100 miles an hour, which means perhaps 75 when



Upper left: The Aeronca Super Chief and, at left, a view of the interior of the cabin of the same ship. Upper right: The Taylorcraft model L-2, an adaptation of the Taylorcraft tandem trainer now being used by civilian pilots

cruising or when bucking a head wind.

There are decided advantages in the low landing speeds of the Piper Cub or the Taylorcraft, which are around 38 miles an hour, but low landing speed also means low loading in pounds per square foot of wing area. This, in turn, means that gusts affect the airplane appreciably. To counteract this condition, we may expect higher wing loadings, and at the same time more liberal use of flaps to increase the lifting capacity in landing and thus reduce landing speeds. Top speeds will certainly pass the 150-mile-an-hour mark. That means cleaner craft, and the introduction of the controllable pitch propeller.

Some authorities today speak of a cruising range of 1000 miles, but this seems higher than needed. Of course, there will never be unanimity in selection: Some people will buy the slower, long range, slow landing, craft; others will want speed above everything. In all probability there will be more opportunity for diverse specifications in the airplane than in the automobile—which is limited in performance by road and traffic conditions and speed laws.

Much of the thinking regarding instrumentation and comfort in private planes of the future can be based on the past of the automobile. As soon as the novelty of the early automobile had worn off, the buying public demanded comfort and gadgets, and got them. So it will in the airplane. Two-way radio will be a necessity on every airplane so that the pilot can keep in touch with the airport control tower. There should be sufficient instruments for blind flying, parachute type seats, hydraulic brakes, controllable or constant-speed propellers, and so on. In the family plane, women will have a great deal to say and will insist on interior finish and comfort comparable with that of the automobile. The noise level of the present private plane is apt to be somewhat high, but this does not disturb keen sportsmen of the air. The more prosaic travelers of the near future will, however, insist on less noise.

It is often said that there can be no private flying until the airplane is safe, and that some miraculous invention is needed to make the airplane safe. A more reasonable view is that the safety of flying is compounded of many factors, and that constant improvement has already made the airplane safe in competent hands, just as the automobile still is safe only in competent hands. There will probably be reached a compromise between ultra caution, too low a landing speed, non-spin, non-stall, and limitation of maneuver, and the very fast, ultra-controllable sportsman's dream.

There is every reason to believe that prices of post-war planes will be very much lower than pre-war. This will be true partly because engines will be so plentiful and cheap, partly because our production methods have been so greatly improved. John M. Hagan, of Aeronca Aircraft, estimates that this reduction should be of the order of 30 to 40 percent. Some well informed people think that a four-seater airplane with a speed of 150 miles an hour will be available at a price of $1500. That would be the aviation millenium and is a little too much to hope for. Mr. Hagan more conservatively estimates the two-seater as likely to cost between $1000 and $2500, and the four-place job between $3550 and $6000, the latter figure to cover the use of two engines in the power plant. One thing is certain: The public will be able to get exceedingly good value for its money. An important point for manufacturers· They should provide wholly adequate facilities for maintenance and repair, and spare parts should not be on the expensive scale of those for military aircraft.

General Aircraft Corporation has opened up a bit in regard to its post-war plans and has released some information regarding a new design which is both interesting and "futuristic."

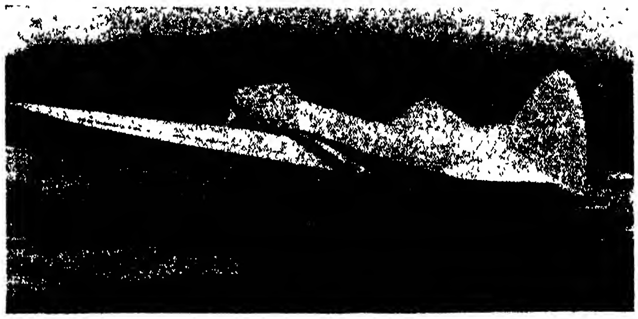
This is a "roadable" machine whose flying characteristics will be similar to those of the Skyfarer Master shown in one of the illustrations. This ship is to have two-control operation: that is, elevator and ailerons only. The same controls are to operate the machine both as a car and as an airplane. The wings are removable and, after having been taken off, are checked at the airport. The plane then becomes a modern streamlined car with a ground speed of 60 miles, powered through its rear wheels. Here is a prophetic quotation: "Our business man leaves his home in the morning in his 'car,' drives to the airport. While having his 'car' filled with gas, the attendants put on the wings, a five-minute job. After flying to his destination, he has the wings removed, drives his 'car' downtown, makes his necessary calls, drives back to the airport, and, donning his wings, goes on to his next destination by air."

The Skyfarer Master itself, as now designed, can provide comfortable air travel for a family of four adults. It is to cruise at 135 miles per hour, have a cruising radius of 600 miles, and gasoline consumption of eight gallons per hour. Here the designers have gone all-out for "two-control," with rudder eliminated, and the airplane is "non-spinnable." A tricycle landing gear, the same controls for the steerable front wheel as for flight, and a landing speed of 40 miles an hour are other features.

W. B. Stout, of the Stout Research Division of Consolidated Vultee, has opened up even more and has given another fascinating picture of the family car-and-airplane of the future. Mr Stout, famous for his vision, his design ability, and his perfect command of Minnesota Swedish in after-dinner speeches, sees flying autos and trucks — planes that fold their wings on alighting and then run along the highway on their four-wheel landing gears.

Howard Stephenson, in "Plane Talk" gives this view of the future: "Your three-passenger family car, which takes wing for week-end trips and vacation jaunts, will weigh 1500 pounds, half as much as a pre-war Ford coupe. It will have a standard 60-inch wheel tread, will do 60 to 70 miles on the highway and will use about as much gas as your old car. Its tires will be standard. Its transparent body will enable you to see everything in sight, including the envious neighbors. For a flying trip, you back the car into a nearby garage, let down the combined wing and outrigger tail assembly, and hook 'er on. The wing spread is 35 feet. A pusher prop is at the rear of the body in order that you may get maximum vision. You taxi across the runway and take off, soaring over treetops . . . at 100 miles an hour. Your cruising range is about 250 miles." The two imaginative pictures on page 199 make the story even more graphic.*

*Some of the more conservative views of the future of private flying were presented in the note "Airplanes of the Future," page 146, October 1943 Scientific American —*The Editor*



Above: The Luscombe Silvaire in flight. Upper right: The Piper trainer, with a high speed of 150 miles an hour. Right: The Skyfarer Master, on which will be based a "roadable" plane

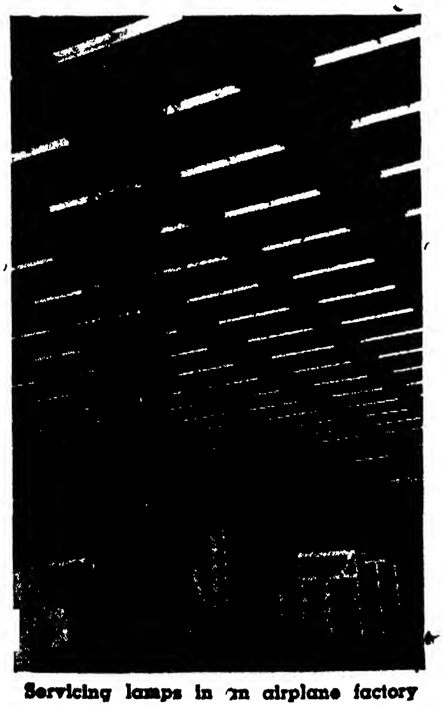
In the matter of private flying, as in everything else, the Government must come into the picture. The requirements of the Civil Aeronautics Administration for private pilots' licenses should be reduced somewhat. The states should not be permitted to license, as the private owner would then have to deal with two licensing bodies. More auxiliary and emergency fields should be government-built. W. B. St. John, of Piper Aircraft, says: "The post-war expansion in flying will be limited only by the utility to which the airplane can be put. Thousands of new airports, landing strips, and seaplane bases must be constructed throughout the country to increase the utility and safety of flying."

The foregoing gives, perhaps, only a shadowy picture of the private plane of the post-war period. But one conclusion is far less shadowy. The American airplane industry has done a splendid job in building a magnificent military air fleet. It certainly will meet the challenge of post-war developments equally as well. Whatever the final form of the private airplane of the future may be, we can be sure that a number of ships having the utmost in popular appeal, safety, utility, and performance will make their appearance in the competitive markets of peace.

FACTORY ILLUMINATION

Kept at High Levels by New Servicing Equipment

Little information is available concerning the advanced types of airplanes now being produced in our factories. That is as it should be; only when aircraft have been brought down over Germany and the enemy can analyze them, should the veil of secrecy be lifted.



Servicing lamps in an airplane factory

But we can learn much from new production methods applied in the airplane plant. Such methods cannot be transplanted, and that explains why production wrinkles, ranging from automatic riveting to conveyor systems for the construction of single-seater fighters, can be more freely discussed.

One of our photographs show a newly developed method of servicing electric lamps, which, while a minor achievement, is a helpful one. The 40-watt lamps are placed 35 to 40 feet above the floor and must provide 33 foot-candles of illumination at working levels, night and day, without a moment's interruption in a completely blacked-out plant. The photograph shows two members of the service crew high in the air at their vital task. The platform, motor driven, has greatly speeded up the work of servicing these lamps in a factory where every inch of space must be brightly illuminated for efficient operation.

DE-ICER

Uses Heat of Exhaust Gas from Engine

The development of a new type of de-icer, in which the heat of the exhaust gases is used to prevent the formation of ice on wings, tail surfaces, and windshield of the airplane, has just been revealed by Tom Girdler, Chairman of the Board of Consolidated Vultee. The idea is not new; experiments with exhaust heat de-icing were made by the National Advisory Committee for Aeronautics several years ago. Nor is the principle at all complicated. Air heated by the exhaust pipes is distributed inside the wing and tail surfaces by suitable ducts, one duct being disposed along the leading edge of the wing. From there the heated air is led to an outlet duct and is discharged in a rearward direction.

Of course, care has gone into the design of a ram air scoop for the heat exchanger, the pump for driving air into the tail unit, the provision of a control gate, and the like. But, on the whole, the application of exhaust heat to de-icing is a matter of straight-forward engineering.

Many other methods of eliminating icing have been tried as, for example, by smearing the leading edge with various anti-icing liquids, but this was not very successful. The Goodrich rubber overshoe, now in general use, has been far more useful. In this method a rubber section is fastened to the leading edge of the wing and, by the aid of air under pressure, the ice is broken away from the wing by inflation of the sections. This method has worked quite well, but is apt to be useless after a certain amount of ice has formed. Also, the inflation of the leading edge and the provision of the overshoe had some detrimental effects on over-all efficiency.

AIRCRAFT HYDRAULICS

Studied With Mock-Up of Standard Parts and Lines

The airplane began with the utmost simplicity of equipment and accessories; the air liner of today is almost as complex as a huge passenger steamship. The hydraulic system in particular is a complicated part of the whole. Thus, the Boeing School of Aeronautics has had its students construct a mock-up of the hydraulic system of the Douglas DC-3 with all standard parts and lines clearly visible. Such a hydraulic mock-up should be generally available also for training airplane mechanics.

Conducted by JAMES M. CROWE

From The Pine

Naval Stores Production is Taking a New Lease on Life. Applied Research, Providing a New Industrial Approach, Has Also Provided New Markets for the Products of the Pine, Promising an Important Future for Terpene Chemistry

In the days when men went down to the sea in wooden sailing ships, tar and pitch, obtained from pine trees, were absolutely necessary to maintain the seaworthiness of ships. Tar was used to preserve the all-important hemp cordage and rigging from the destructive corrosion of salt spray and damp air. Pitch was used for caulking seams with oakum, for ship bottoms, and for many other nautical uses.

Because of this close association with shipbuilding and maintenance, it was natural that such a name as "naval stores" be applied to these materials, and this term has stuck to this day, in spite of the fact that they have long ago lost their intimate connection with the shipping industry.

As the uses in connection with ships declined, other uses took their place and the naval stores industry developed. In a broad sense naval stores today include various kinds of turpentines, rosins, pine oils, rosin oils, tars, and pitches, obtained from the oleoresinous secretions of various species of coniferous trees, notably the long leaf and loblolly pines found in our southern states.

From 60 to 70 percent of the world's production of naval stores comes from the United States. Of the remainder about half comes from France, with Spain, Greece, Portugal, Mexico, and India following in order. Smaller amounts come from Austria, Russia, Finland, Scandinavia, the Philippines, and Japan.

'Naval stores are made by four principal methods which differ fundamentally in the methods of extracting the resinous material which is produced by the metabolism of the living tree and is stored up in microscopic channels called resin-ducts, from which man drains it.

In the first method the gum is obtained by tapping the tree. Travellers have often been impressed by the sight of thousands of white-faced pine trees with metal pails or baked clay cups, shaped like flower pots, fastened to their trunks. These trees are the production plants for oleoresin, a grayish white secretion given off when the tree is wounded or cut. How this resin is formed, or what part it plays in the life of the tree is little understood. It is not to be confused with the sap in the tree which circulates through the fibrous cells of the sapwood and cells of the soft inner bark. The oleoresin is sometimes thought to be a by-product of cell metabolism—waste or excreta. So long as it is done properly, tapping seems to have no ill effect on the health of the tree.

If the tree does not have vital uses for this excreta, man certainly has, and thus the turpentiners start their operations by chipping a "face" of the tree with a wide v-shaped incision and inserting a gutter to carry the secretion to the cups attached to the tree. Each week, beginning in March and continuing through October, the chippers make a new incision in the bark, each one a little higher than the previous one, to start a fresh flow of oleoresin.

Experiments in the last year or so have shown that the flow of this material may be stimulated by the application of sulfuric acid or caustic soda to the incisions, and thus make possible more efficient production and higher profits.

Collecting gum in a pine forest

At regular intervals, a crew of dippers makes the rounds, gathering the raw gum from the cups, which is poured first into buckets and then into barrels. These barrels are then hauled to central plants where the contents are separated by simple distillation into the liquid fraction, gum turpentine, and the resinous residue, gum rosin. The rosin so produced is then filtered hot to remove foreign materials. The products thus obtained are collectively known in industry as "gum naval stores."

Both rosin and turpentine are produced from sap taken from pine trees which are "stripped" once a month to keep the sap flowing. The workman in this picture is cutting parallel gashes that slant downward and toward each other. Keeping surface open assures steady sap flow

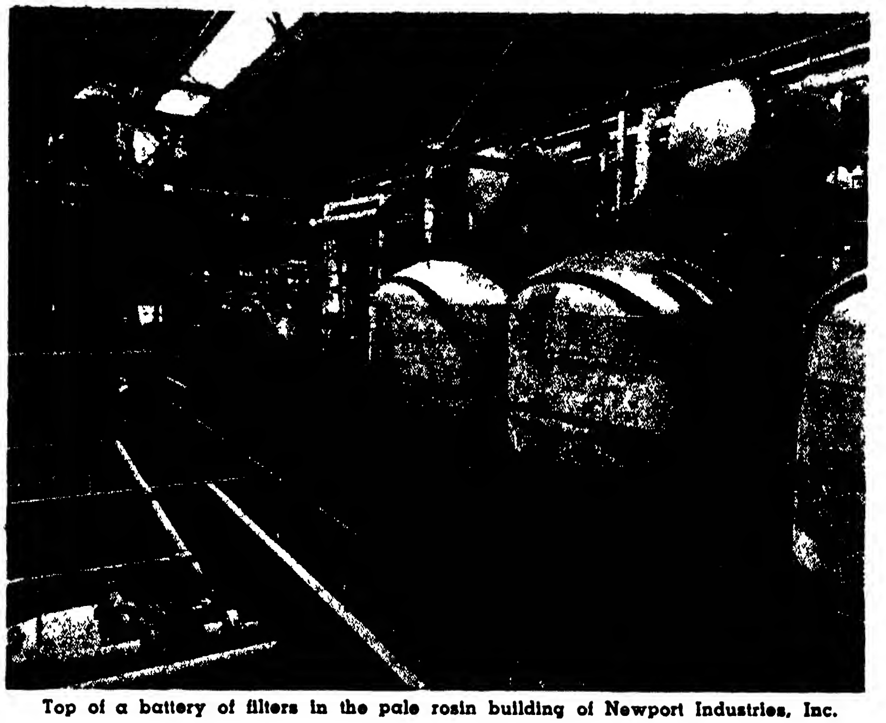
The second method is known as solvent extraction. By this process, discovered about 1906, wood and stumps rich in oleoresin are shredded, steamed to open the pores of the wood, and then processed with hot mineral solvent. The extracted material, consisting of terpene liquids and resins, is separated by distillation and further refined Products made by this process are called "wood naval stores."

The development of this process has been of great importance to the South because, through it, the wholesale butchery of southern forests by early wasteful lumbering operations has been partly alleviated. It has made it possible profitably to clear and reclaim vast areas of cut-over timberlands where lumbering operations had left nothing but stumps and refuse. These cleared lands can then be reseeded in quick-growing pine, used as pasture land for the South's growing dairy industry, or planted to some other new crop, such as the tung tree which yields tung (chinawood) oil, a valuable raw material for paints and varnishes.

The third source of naval stores is the sulfate process of making wood pulp. In this process the oleoresinous components of the wood are removed by chemical action. Sulfate wood turpentine is recovered by condensing the vapors released from the pulping digestors. The crude by-product is heavily contaminated with sulfur compounds which are removed by chemical treatment and fractional distillation. The spent cooking liquor obtained from these paper mills, commonly called "black liquor," is treated to recover a

mixture of fatty and resin acids called "tall oil." With the increasing development of southern paper mills, new processes will undoubtedly be discovered to utilize more efficiently both the fatty acid and resin constituents of tall oil, and thus create new wealth from a material formerly largely wasted.

The fourth method of obtaining naval stores is by destructive distillation. In the early Colonial days this was a popular method because it required no equipment. Dead pinewood, which seldom decayed because of its high resinous content, was gathered and cut into convenient sizes. A circular mound of earth was made and packed hard and coated with clay, except for a hole in the center which was connected by a conduit to an outer basin dug in the earth. The wood was stacked on this base and the kiln was completed by covering the wood with pine leaves and then with clay or sod. The pile was then kindled at the top and the fire gradually penetrated to the bottom in slow combustion with insufficient oxygen. It often took eight or nine days to complete combustion. In the meantime, the tar collected in the outer basin and was drawn off and strained.



Top of a battery of filters in the pale rosin building of Newport Industries, Inc.

In the modern destructive distillation process, the stumps and branches are loaded into steel cars which are run into retorts. After sealing the retort to prevent the entrance of air, heat is applied from the outside and the volatile products from the decomposition of the wood and resinous material pass off and are condensed.

Naval stores are used today in almost every industry: To name a few—paint and varnish; soap; oils, greases, and printing inks; shoe polish and leather dressings; sealing wax and insulation; linoleum, oil cloth, and roofing; foundries and foundry supplies; paper; shipyards; pharmaceuticals and chemicals.

The paint industry still consumes the largest amount of turpentine, although changes in formulation of protective coatings in recent years have made petroleum and other solvents more desirable and have reduced the demand for turpentine. As a solvent for waxes, turpentine is still extensively used in shoe polish and stove polishes. It is an ingredient in many insecticides, both because of its solvent and insecticidal properties. A large amount is still sold direct to households in small retail packages

Consumption of rosin is spread over diversified fields. Tremendous quantities go to the paper industry for use as a sizing material to improve greatly the strength and surface of papers. More than 135,000,000 pounds of rosin are used in the United States each year in the manufacture of soap. For many years, rosin was used only in laundry and industrial soaps—the familiar, cheap, dark brown variety. Its use depended to a large extent on the price of soap oils. When these oils were dear, more rosin was used; when cheap, less rosin was used. Recently, however, a large naval stores producer, through intensive chemical research, has developed grades of chemically modified light-colored rosin which actually improve both bar soap and soap powder, and may be used in amounts up to 15 percent. Before the war the use of rosin in soap was declining, but it now looks as if it will come back strong when chemical manufacturers are able to go into production on these new rosin compounds after the war.

A stock pile of pine stumps, at the Brunswick, Georgia, naval stores plant of Hercules Powder Company, used in production of turpentine, pine oil, and rosin

In fact, it is to similar chemical research that the naval stores industry in general has turned in the past decade in an attempt to pull itself out of the doldrums and to develop new uses for these materials

One of the most noteworthy of these research developments is the manufacture of synthetic camphor out of chemicals from the pine tree. This process, perfected in the last ten years, broke the back of the high-priced Japanese monopoly on natural camphor and assured us of a continuous supply of an important medicinal and industrial material. Turpentine also serves as the raw material for the production of dipentene, terpineol, and pharmaceuticals such as terpin hydrate, terebene, and a number of other pure compounds.

In the paint and varnish field rosin was fighting a losing battle, because it gave finishes that lacked hardness and water resistance and because its acidic nature caused trouble with certain basic pigments. The chemists got busy and combined rosin with alcohols to form chemicals called methyl and ethyl abietates, and with glycerine to form ester gum. These products now find

great favor in the trade and with other ingredients form many of the better type of water-resistant varnishes.

In the last few years naval stores have also become raw materials for a great many new chemicals, with a wide range of uses as varied as in perfumes, synthetic rubber, and drugs.

In the light of what has been done, it is reasonable to believe that before long this new branch of terpene chemistry will take a more important place alongside the fields of coal tar, cellulose, and petroleum chemistry. Thus with its new approach to progress through research, the naval stores industry may regain much of its early prestige and importance as one of America's oldest, and the South's greatest, enterprises.

● ● ●

CHEMICAL CLEARING HOUSE

Assists Research Workers in Quest of Rare Chemicals

MOST workers in chemistry have often wished for some sort of clearing house to which they could turn when they needed a rare or uncommon chemical compound. They quickly found out that there was no such place and either had to turn detective and hunt down a source or roll up their sleeves and synthesize a small quantity of the compound for themselves. In either case it was a hard job and wasted much valuable time.

Thus it was a happy day for research workers when the Armour Research Foundation decided to do something about the situation. What they did was to form a National Registry of Rare Chemicals, a clearing house for information to be maintained, without charge, in the interests of the scientific work of the nation.

The object of the service is to inform a chemist, or for that matter any research worker, where he can get a rare or unusual chemical. The Registry is not a "chemical bank," inasmuch as it does not buy or sell materials, but merely maintains an indexed file of sources. Chemicals which can be found in the catalogs of regular suppliers are not included in the file.

The Registry passed its first birthday a few months ago and was able to look back on a year of successful service during which it has saved the valuable time of research in nearly every industry in private laboratories, and in educational institutions.

BATTERY RETAINER

Made from Byproducts of Plastics Manufacture

A PLASTIC storage-battery retainer manufactured from polystyrene, for use in certain types of Exide batteries, not only has technical advantages, but is also said to be more permanent than the former type of retainer, according to the Electric Storage Battery Company. In addition, as it is now being manufactured, it uses less critical material.

"Development work on the new retainer was started in the Exide laboratories before the outbreak of the war," states L. E. Lighton, Manager, Development and Design Department. "The object of this experimental work was to find a material superior to existing retainers from both the performance and manufacturing costs angle. Extensive field tests were undertaken and Exide was virtually ready to put the new plastic retainer on the market when the war effort of our Allies began to demand the raw material from which it was to have been made.

"This presented a double problem, as the shortage of rubber later made it even more urgent that some way be found to produce the new plastic retainer without drawing upon the supply of another critical material. Work on this newest phase of the development was begun in spite of what seemed a hopeless task with so many plastics being rapidly put on the critical list. However, our research laboratories again went to work on the problem, and the result is the new slotted polystyrene retainer which Exide is now putting on the market.

"Although the basic raw materials are still on the critical list, the new polystyrene retainer can be manufactured from secondary materials, byproducts from the use of this material for other war purposes. The result is a retainer that marks a distinct step forward in battery design just as the slotted rubber type, which was developed years ago, did in its day."

CHEMICAL PEELING

Potato Skins Removed Rapidly By Use of Caustic Soda

THIS SEEMS to be an age of freedom from this and freedom from that. President Roosevelt proposes four freedoms, then someone else ups him to six or eight, and so on. Not to be outdone, industry is also seeking new freedoms. One of the latest is freedom from peeling potatoes. According to recent research work, definite progress is being made on the removal of vegetable skins by the use of solutions of lye, or caustic soda.

The increasing demand for canned potatoes and especially the huge requirements of dehydrated vegetables for the armed forces and Lend-Lease has stimulated the investigation of methods for improving lye-peeling processes which for several years have been used in a very limited way for the peeling of small, freshly dug potatoes used by canneries in Delaware, Maryland, Virginia, and southern New Jersey.

During the past two years several new lye-peeling installations have been made for larger and tougher skinned potatoes. The work thus far has indicated that, for large tonnages, peeling with a lye solution is more economical than by any other method. Skin and eye removal is accomplished with a minimum weight loss ranging from about 10 to 15 percent, depending upon the condition of the potatoes.

The peeling is carried out by the following operations: Potatoes are dusted and washed in water and then immersed in a caustic solution of just the right temperature and concentration. They then go to a washer which provides mechanical action and water to carry away the skin and thin, yellow, gelatinous layer formed in the lye bath. When the potatoes are finally rinsed, they appear gleaming white, with no trace of lye left. They are then ready for canning or for slicing and dehydrating.

ANTI-FREEZE

Reconditioner Restores Anti-Rust Properties

A NEW chemical inhibitor for reconditioning last winter's anti-freeze solution is now available to car owners, according to G. W. Sherin, Director of the Chemical Specialties Division of the Du Pont Company. The new compound, developed last year for the United States Army, is being released for civilian use in co-operation with a WPB request that motorists conserve their old anti-freeze solutions.

"Many car owners have removed their last winter's anti-freeze, and stored it for re-use," Mr. Sherin says, "in anticipation of the anti-freeze shortage expected this winter. This is a sensible plan, but anti-freeze should not be used a second season unless it is reconditioned.

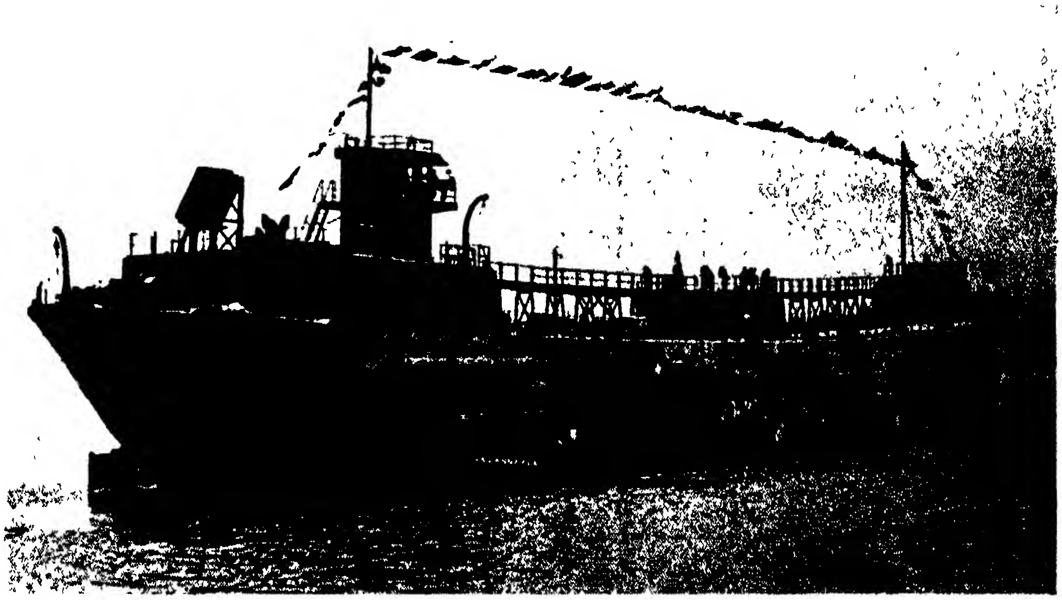
"Automotive engineers have learned that some types of anti-freeze lose their rust-inhibiting properties and become acid after extended use. If they are reintroduced into a cooling system without being treated with an inhibitor, they will promote rust and corrosion. The acid may attack the metal parts.

"The WPB Conservation Division, aware of this danger, recently recommended that a re-inhibitor be added to the stored anti-freeze to make it safe and efficient for future use," Mr. Sherin says.

The new product does not contribute to the anti-freeze properties of a solution, Mr. Sherin cautions, but simply neutralizes any acid formation and restores the lost rust inhibitor. When treating the anti-freeze, it is advisable also to filter it in order to remove dirt and rust particles.

Ethylene-glycol "permanent" anti-freezes need reconditioning more than the alcohol types, Mr. Sherin adds, but the new inhibitor can be safely used in any standard anti-freeze solution. In fact, it may also be used as an anti-rust with plain water during the summer months.

"If the car owner has allowed his anti-freeze to remain in the cooling system during the summer, it is wise to add the reinhibitor. While most standard anti-freezes retain their rust inhibitors as long as they remain in the cooling system, the inhibitors may lose their strength, and acids may develop. It is best to play safe and recondition the anti-freeze solution," Mr. Sherin says.



A concrete tanker just after launching at a Georgia shipyard

ENGINEERING

Conducted by EDWARD J. CLEARY

Seagoing Concrete

Many Lessons About Good, Light-Weight Concrete are Being Learned During the Construction of Large Vessels, Both With and Without Power, for the Current United States Maritime Commission's Program. Some of these Ships are Already Aiding the Allied Cause

By HAL W. HUNT

After a lapse of more than 20 years, concrete ships are again sailing the seas as cargo carriers. Constructed for the United States Maritime Commission as a war measure, they are one third the length of any ship afloat and their overall dimension of 366 feet at the water line compares with 441 feet length of the well known Liberty freighters of steel. With a beam of 60 feet and a depth of 40 feet, their cargo-carrying capacity ranges up to 6000 long tons. Flying the American flag, some of these vessels of "stone" and steel already are playing a part in moving war goods.

Some of the new concrete units are called barges because they are not equipped with individual power units. But all of them are conventional, ship-shaped vessels, and the barges are capable of being towed to any port in the world.

In this war, as in World War I, concrete ships were adopted because sufficient steel plate rolling capacity was not available for fabrication of all the ships required for full prosecution of the war. Then, too, the use of concrete, a material with which many construction men are familiar, opened a new source of skilled manpower to supplement the army of workers being trained for the specialist tasks in shipbuilding.

The first cost of a concrete ship is substantially less than that of a comparable steel ship For example, a Liberty freighter (E.C. 2 type) costs $1,800,000 to $2,000,000. A concrete ship with two thirds the carrying capacity can be built for about $1,000,000. However, concrete ships are considered less economical to operate than are those built of steel. Since they have much greater hull weight than steel ships of comparable carrying capacity, they require more power for propulsion and they are slower and less maneuverable.

During and immediately after World War I, twelve concrete ships were completed for the United States Shipping Board, the equivalent agency of the present Maritime Commission. Several more concrete vessels were constructed by other governmental and private interests. The Shipping Board vessels ranged in size from 3000-ton cargo boats to 7500-ton tankers, the latter more than 450 feet in length. One of these vessels, *Faith*, voyaged to Vancouver, Honolulu, Chile, New York (via the Panama Canal), and later to London. Other concrete ships made numerous coastwise voyages and were engaged in the West Indies and South American service.

The current Maritime Commission program of concrete ship construction includes 65 reinforced concrete tanker barges under contract; 77 more are authorized. Each of these vessels has a capacity of 40,000 barrels (about 2,000,000 gallons), and is intended to carry medium-density fuel oil, such as is used in homes and small industries.

Also under construction are 26 dry-cargo barges intended for operation between the United States and Latin-American countries, and 24 self-propelled reinforced concrete freighters, intended primarily for transportation of bauxite ore from which aluminum is made.

More than 50 sea-going tugs, some of the most powerful ever used, are being built to tow the 91 non-powered vessels.

Concrete is a material that is almost as easy to mold into shape as clay, but the forms required to mold it in the desired thickness and prescribed lines for a ship are difficult to build and hold in place.

Since concrete can be formed into any type of streamlined shape, some proponents of concrete vessels feel that designs following the conventional ship lines established for steel vessels should be abandoned in favor of a circular or semi-circular compartmental design. They point out that in the period immediately following World War I, two tankers based on this type of design were constructed and were in satisfactory operation for some time.

Concrete for ships must be watertight, unusually strong and durable, and light in weight. All concrete, of course, does not meet these specifications.

Ordinarily, the best concrete is the heaviest, since it is made of the densest

ingredients. The aggregates used are so proportioned that every space between larger pieces is filled by smaller ones down through the finest sand. Then the cement, finer than flour, serves to coat all the particles with a fine grout that binds all of the materials together.

Good concrete, prepared by conventional methods and vibrated so that it forms a dense mass, weighs about 150 pounds per cubic foot. Walls 4 to 6 inches thick are necessary to provide the required strength and to cover the steel needed for the tensile reinforcement of a ship. Concrete in the bottom, side-shells, and decks of a ship would then weigh 50 to 75 pounds per square foot of surface, compared with about 25 pounds per square foot for 5/8 inch thick steel plating usually used on a freighter.

Nearly half of this weight differential can, however, be overcome by using lightweight material from which to make the concrete. The aggregate most commonly used is sold under the trade name Haydite, and is a burned and crushed clay product. This material, developed during World War I although not widely used in the ships built at that time, has found many industrial and commercial uses.

Coarse Haydite, up to 3/8 and 1/2 inch in diameter, weighs about 35 pounds per cubic foot (comparable gravel or stone aggregate weighs 90 to 105 pounds) and the fine aggregate, smaller than 1/4 inch diameter, weighs about 42 pounds per cubic foot. Concrete weighing about 108 pounds per cubic foot and having a strength of 5000 to 6000 pounds per square inch, when tested in compression at the age of 28 days, can be made from this material using 9 to 10 sacks of standard Portland cement per cubic yard.

A new type of lightweight aggregate is now being made at a plant in Florida using a nodulizing process on pulverized fullers earth. In this process a fine spray of water, with different size droplets, is impinged on dust-dry fullers earth particles. This forms different size nodules, much as raindrops gather dust. Moisture holds the nodules together until they are burned into a hard clinker from which the lightweight aggregate is made. Developers of the process claim that the aggregate is more satisfactory than the clay product, as it is less absorptive. Furthermore, it is said that the rounded particles flow better than the crushed particles of clay and thus will "fill-in" better around the reinforcing bars.

Both types of lightweight aggregate require the addition of a small amount, about 15 percent, of natural sand aggregate because manufacturing processes now in use do not produce enough fines to make the required watertight, dense concrete.

Use of the lightweight aggregate makes it possible to build concrete ships that will carry an average of 5500 long tons of cargo, compared with the limit of 4300 tons that would be carried in a similar ship made of "stone" concrete.

Considerable reinforcing steel—about one-half or more of the weight of plates required for a steel ship of the same carrying capacity—are needed to give structural strength to a concrete vessel

The design followed in Maritime Commission ships calls for very heavy reinforcing steel, particularly in the bottom of the vessel. The principal reinforcing consists of two layers of 1 inch square bars spaced 2½ inches part and welded so that they are continuous throughout the full length of the vessel.

Bars in the side-shell are smaller, spaced farther apart, and are lapped instead of welded for continuous strength. Deck bars are welded to take the greater stress caused by "beam action," such as would occur when waves roll under the vessel. Wave action of this kind sometimes causes the entire ship to be supported in the center only, and the two ends are left "hanging" in the air, thus producing high reversed stresses.

The exterior shell of the ship as well as the deck are stiffened and supported by frames of reinforced concrete at about 10 feet center to center. A solid transverse bulkhead or wall at intervals of about three frames, and one or two solid longitudinal bulkheads, are used to stiffen the ship further. These bulkheads serve as watertight barriers should one section of the hull be damaged. Between the widely spaced frames in the bottom, sides, and deck, the shell is strengthened by longitudinal concrete beams placed integrally with the hull.

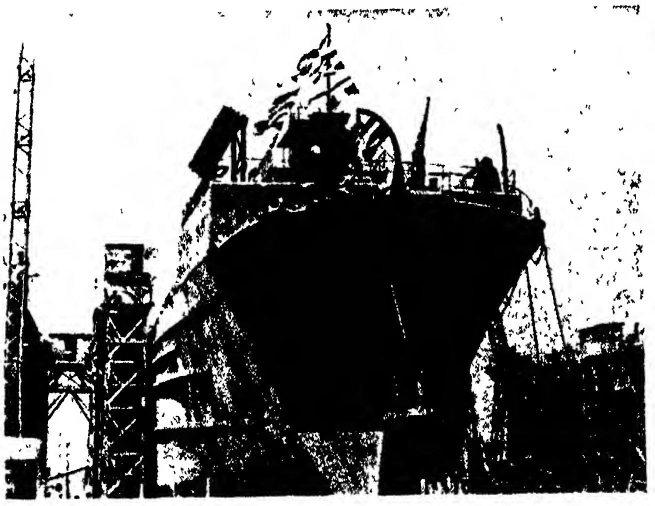
Concrete ships are constructed on end-launching or side-launching ways, also in building basins, which are similar to graving docks. Use of the building-basin method is preferred, because when the ship is completed it can be floated off the supporting structures without strain.

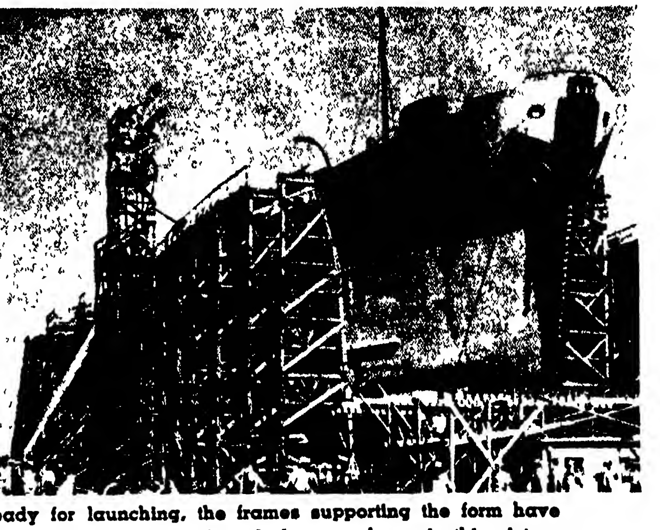
Concrete is placed in wood forms that are carefully tied and braced to hold them in exact position to assure smooth lines for the exterior of the hull as well as correct alinement for all parts of the vessel. Forms usually are made of plywood, backed up with heavier wood members. Some of the more intricate and small interior forms are metal faced.

The usual procedure is to erect the exterior form complete, then place the reinforcing and forms in the bottom of the hull and up to a height of 3 or 4 feet above the lowest point of the keel. Concrete is then placed to this level, followed by the placing of reinforcing steel and forms for an additional lift up to about the deck line. The decks are placed in later pours.

Great care must be exercised to assure watertight concrete and watertight joints, particularly below the water line. Therefore the concrete for ships must be of the highest quality, achieved by careful control in mixing and placing. It is always placed in small quantities, largely by hand, then carefully vibrated to minimize the occurrence of voids.

To increase the strength of the concrete and harden the exterior surface, some builders of ships are using a "vacuum" process for removing water from the concrete in excess of that needed for hydration of its cement. This is accomplished by building into the exterior form for the ship a "vacuum mat" of expanded metal mesh, a layer of screen wire, and a non-waterproof canvas cover. A pipe-flange is attached over a hole in the plywood form and a vacuum, equivalent to 20 inches of mercury, is "pulled" on the concrete by special pumps. The bottom and other horizontal surfaces of the ship are processed





Left: Stern of a concrete barge. Although the vessel is ready for launching, the frames supporting the form have not been removed. Right: The forepeak of a concrete barge uses a small amount of steel plate, as shown in this picture

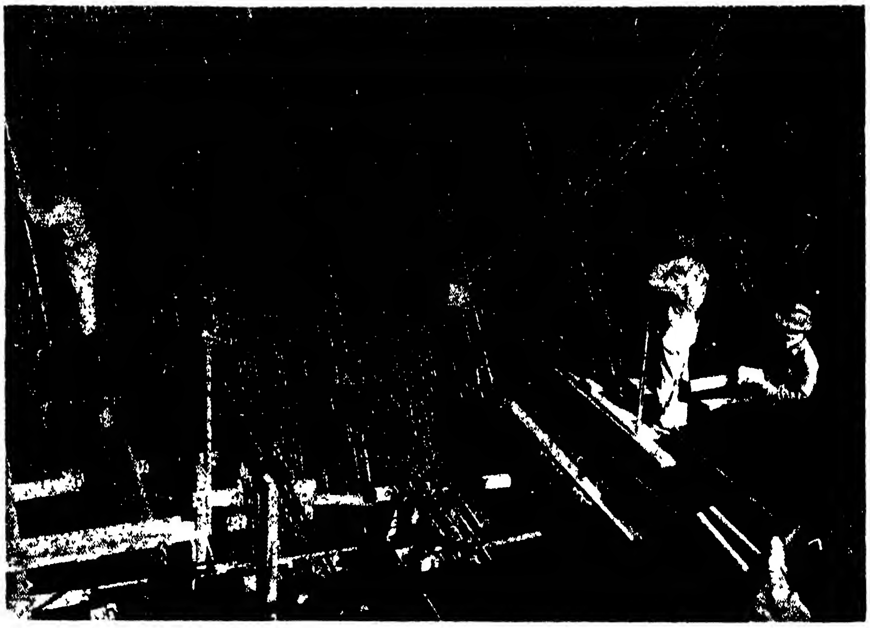
by portable mats of similar construction, which are used for a few minutes to draw the excess water from a small area and then moved ahead to follow the concrete placing.

Despite all precautions taken to assure perfect concrete, it is found that some patching usually is necessary where "honeycomb" or minor cracks or foreign matter are found in this material. Patching is done by cutting out the objectionable concrete and refilling the opening, being careful to pack the new material tightly into place.

Each compartment of the tanker hulls is tested for watertightness with a static head of 46 feet of water on the bottom, equivalent to a force of 2880 pounds per square foot. This pressure and the stresses from filling the tank with water, opens up any minute channels that may exist or be incipient through the concrete. Even a little sawdust dropped on the concrete while it is being placed may create a channel that will permit a small amount of oil to escape or salt water to enter. At every point where there is indication of moisture, small holes are drilled into the concrete, as deep as the reinforcing will permit, and cement grout is forced in with an impact grout gun.

The United States Maritime Commission, under whose direction the concrete ships are being built, is headed by Admiral Emory S. Land, USN (retired), chairman, and Rear Admiral H. S. Vickery, USN, Vice-Chairman. Chief of the concrete construction section is R. D. Karr who works with James L. Bates, director of the technical division.

The concrete vessels are being built at yards on the Atlantic, Gulf, and Pacific Coasts. Concrete Ship Constructors, in California, are building tankers in basins; original contract for 22 ships has been augmented as completion of vessels indicated the need for ordering further materials. The MacEvoy Shipbuilding Company, in Georgia, is building 23 tankers on six end-launching ways while San Jacinto Shipbuilding Corporation, in Texas, have four side-launching ways in use.



The engineering level is set on the rudder post. Note forest of reinforcing bars

Dry cargo barges, 26 are under contract, are being built by Barrett and Hilp in basins on San Francisco Bay. The only powered concrete ships so far contracted are 24 units being built by McCloskey and Company in basins in Florida.

In contrast to World War I, when hostilities ended before any concrete ships were completed, we are now using concrete ships in active theaters of operation. Some of the tankers, for example, have been towed loaded to the South Seas where they are now serving as mobile emergency storage tanks for the Navy. And, recently, dry-cargo boats have also been put into service.

TIMBER CONSTRUCTION

Reaches All-Time High During 1943

ALL-TIME records for timber construction were established during the first half of 1943, when the largest amount of wood ever used in a building—27,000,000 board-feet—went into a cargo-plane assembly plant. Largest clear-span timber arches ever erected were used in a blimp hangar; they rise 153 feet from the floor and span 237 feet.

CHLORINATED WATER

Tested by New Simplified Method

TESTING water purified with calcium hypochloride for residual chlorine is simplified by a new method developed by the Quartermaster Corps in collaboration with the Medical Corps and several industrial chemical companies.

The testing method employs orthotolidine in a newly developed tablet form rather than in solution, each tablet representing one cubic centimeter of the liquid. Orthotolidine, a chemical reagent that produces an intense yellow-green color in the presence of chlorine, is widely used for determining the extent of chlorination of water.

The tablets are packed in a nested double tube, the inner one of glass containing 50 tablets, and the outer one of plastic serving as a tube for the testing operation. The outer tube has a ¾-inch transparent yellow band at the top showing the exact color the water should have when tested after chlorine treatment.

In the testing operation, the outer tube is filled to the lower edge of the yellow band with the treated water and the tablets are dropped into it and allowed to dissolve. If the resulting color of the liquid in the tube is lighter than the color of the yellow band, the water requires more treatment with chlorine, while an equal or slightly darker color indicates the water has been satisfactorily purified and is safe for use. If the liquid turns an orange color, the water is too heavily treated with chlorine and more untreated water must be added to the supply being tested.

The new testing method was devised to replace the more complicated conventional method employing orthotolidine in liquid form.

TIMBER MOISTURE

Removal With Solvents Now Being Tested

A PLANT for checking commercial possibilities of a process for extracting oil, resin, and moisture from timber by means of solvents is being built by the Western Pine Association in Portland, Oregon.

The idea for this unique curing method came about as a result of experiments on removal of oil and resin from knots to prevent "bleeding" through paint. During these experiments it was discovered that the solvents reduced moisture content to a surprising degree, keeping the wood lighter in color than when dried in a kiln.

A notable characteristic of wood treated by the extraction method is said to be its readiness to absorb liquids, such as preservatives, water repellents, fire retardants, and coloring matter or stains.

SHIPBUILDING SPEED

Is Producing Vast Merchant Fleet

A THUMBNAIL sketch of our shipbuilding progress reveals that we will produce 19,000,000 deadweight tons of dry cargo ships in 1943, almost the equivalent of the entire British merchant fleet at the start of the war. Over 700 ships have been turned out so far this year. Expected to require 210 days to produce, the average time from keel-laying to delivery has been cut to 50 days per ship.

Conducted by FRED P. PETERS

Pressing Metal Into Service

As a Result of Production and Conservation Requirements, New Technical Knowledge has been Acquired on the Use of Pressed Metals in Jobs that Formerly Have Been Done by Other Methods. Time and Materials are Saved Without Sacrifice

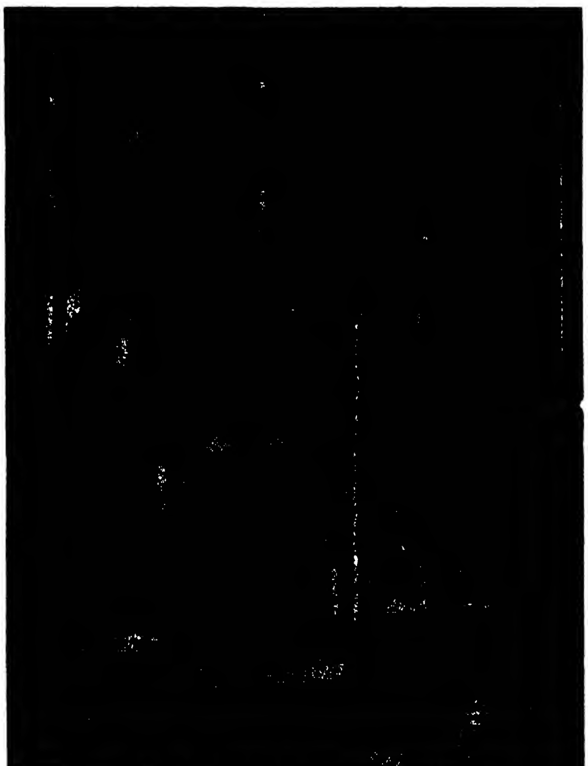
THE PRESSING problems of modern war production have been solved in hundreds of instances by nothing less than presses themselves—presses applied to shaping and forming metal into vital munitions or machinery components. Three of the war's biggest production engineering developments have involved the working of metal in presses, and a large segment of our over-all conservation achievement is directly attributable to the availability and use of metal-stamping presses on a wide scale.

New technical knowledge of press-working has contributed to these uses. And conversely, out of this broadening application have emerged new techniques taught by war-production, as well as increased respect among engineers for the utility of pressed-metal fabrication as a manufacturing tool.

The versatility of presses as metal-working tools is partly the result of considerable diversity in types and designs available. For almost any purpose requiring presses one may employ either a hydraulic press or a mechanical press. Presses are rated in capacity according to the maximum load that can be applied; the largest presses in use today have capacity ratings in the neighborhood of 6000 tons.

In its essence, a metal-working press is a machine with a sturdy stationary component, in which the metal being formed is held, and a moving component that applies pressure to the metal. Dies are often employed to reproduce contours to accurate dimensions. Some familiar types of presses are (a) blanking presses, which knock flat shapes out of flat sheets of metal; (b) forming presses, which make bulges, turned-up edges, flanges, cups, domes, and so on, in what was once a flat sheet; (c) stamping presses, which do both of the foregoing in one operation, knocking out finished parts in many cases from a flat piece of metal; (d) drawing presses, which form cup- or bowl-shaped parts, tubes, or cylinders out of flat pieces; (e) forging presses, which push hot metal into desired shapes, with the aid of dies; (f) extrusion presses, which draw out solid billets of round or rectangular cross-section into long bars of often intricate cross-section; (g) piercing and drawing presses, which convert a *solid* bar or billet into a longer *tube* or *pipe;* and (h) powder metallurgy presses, which press metal powders held in dies to "briquettes" of roughly finished shape, ready for a consolidating heat treatment.

There are other important types of presses and metal-pressing operations, but out of the aforementioned group have come some of the most significant technical achievements of our war production effort. For example, the development and present manufacture on a large scale of steel cartridge cases has been called by Major General Campbell, Ordnance Chief, one of the outstanding mechanical accomplishments of this war, and it all centered about the successful use on *steel* of press equipment originally designed and built for drawing *brass* cases.



Courtesy American Magnesium Corporation

Magnesium wheel covers for airplanes receiving the second cold draw in their production

In World War I the Germans had tried with only limited success to produce cartridge cases of steel instead of the traditional brass. American success with the problem in this war has been complete, for steel cases are being made in practically all calibers, the ammunition on which they are used can be employed in barrage fire (German steel cases of World War I could not, because cases could not always be extracted properly), and several hundred thousand tons of copper and zinc per year are being saved for other uses.

The technical problem involved the production of a case (1) made of steel, (2) on presses like those used for brass, (3) economically and on a high-production scale, (4) whose wall would be elastic enough to expand at the moment of explosion and make a tight seal against the breech of the gun, and then to contract to permit ejection; and (5) whose body must be strong to resist the stresses of firing but whose mouth must be very soft to insure complete seal against back-fire of the propellant.

These physical properties in the steel are obtained by the cold work of the pressing operation. The operations had to be modified, additional draws introduced, new types of dies employed, and so on, for steel draws less easily than brass (the stress within the elastic range to produce a given amount of extension in brass is approximately one half that of steel), "picks-up" on the dies to a greater extent, and corrodes more rapidly.

Yet more than 50 manufacturers are now making steel cartridge cases, thanks to the co-operative efforts of scores of American manufacturers, engineers, and Army and Navy ordnance officers.

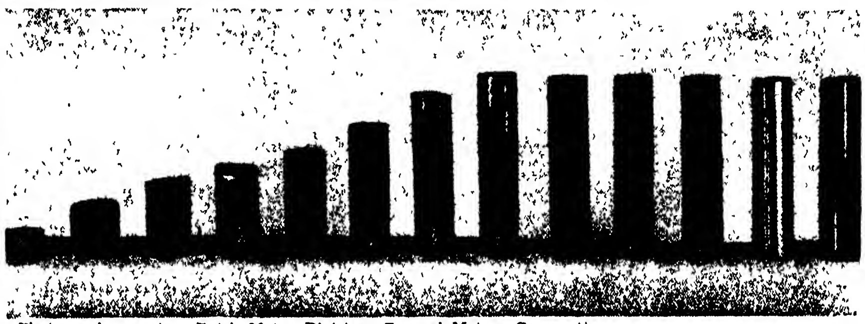
Steel cartridge cases and pierced-and-drawn gun tubes are two single large-scale applications of metal-pressing to the winning of the war. Of at least equal importance as a contribution to Victory has been the systematic and widespread conversion to stampings of numberless ordnance products formerly made by methods involving much waste metal, excessive machining, or inordinately long production-time.

Stamping and allied metal press-working operations provide several advantages over casting, forging, or machining for many military items. Once the dies for stamping have been made, production is rapid and economical and parts are interchangeable. The parts as they leave the stamping press often require no machining, so that the slow and wasteful removal of surplus metal is largely eliminated. Scrap from stamping operations is usually much less than that from machined bar stock, castings, or forgings. Very often, too, steel stampings are able to provide sufficient strength even in thin sections to match the properties obtained conventionally in thicker sections of more critical brass or

aluminum forgings or castings.

These are the same advantages that enabled pressed metal fabrication to cut costs in peace-time mass production. Early automobiles, for example, used rolled shapes, castings, forgings, and wood in their construction. The modern car is made largely of pressed steel—especially the frame, body, wheels, and fenders. To a large extent, so were refrigerators, washing machines, oil burners, electrical appliances, and so on, and these and similar markets kept 880 stamping and press-forming plants going to the tune of $277,000,000 worth of business in 1941.

But in 1942 the stamping industry's level of operation had fallen to 25 percent of capacity through curtailment of manufacturing in the automobile and other consumer product fields, and the situation of many of the plants, with idle machines and equipment, yet plenty of "know-how," was desperate indeed.



Photographs courtesy Buick Motor Division, General Motors Corporation

Illustration at the top of the page shows a general view of a press used for drawing steel cartridge cases. At the left is a close-up of the same unit. Directly above is a line-up of the forming operations from bar to finished cartridge case

Then came The Great Conversion, one of the truly great production achievements of this war. Ordnance items were largely designed as castings or forgings, or to be machined from bar stock. It became apparent to ordnance officials and WPB early in the war-production program that facilities for these types of fabrication would be swamped. Alert stampings manufacturers saw these casting, forging, and machining bottlenecks on one hand and their own idle presses on the other, and determined to do something about it.

One of them redesigned a number of ordnance parts to permit fabrication by stamping and submitted the new designs to the Chief of Ordnance in Washington, where they were enthusiastically received. Then, to facilitate the redesign on a large scale of other ordnance and aircraft products, the Ordnance Department established in May 1942 a Suggestion and Conversion Section in Washington and in the 13 Ordnance District offices, while the stamping manufacturers formed the Pressed Metal Institute to assist in surveying available equipment and in subcontracting.

This collaboration has been tremendously successful. During the first month 50 ordnance products were studied and 17 approved for conversion from forgings, iron castings, or machined bar stock to metal stampings. Suggestions are "screened" and processed in the district offices before being sent to Washington; up to the middle of this year 2708 redesign suggestions had been thus handled, of which 1042 are now in production.

These conversions to stampings have been limited chiefly to small parts, which also happened to have been the biggest bottlenecks. Frequently metal has been saved by reducing the weight of the finished part. At times a press assembly or a brazing operation or spot welding has joined several small stampings to duplicate a machined piece.

Irregular shapes that could be machined only with great difficulty are now produced in a single rapid operation on stamping presses. Locating-holes are punched in the same operation that produces the stamping, and the cost of a jig for drilling and the extra machine-time are obviated. And, as mentioned earlier, aluminum, brass, Monel, and other critical metals are replaced by steel with no sacrifice in strength and often with a lowering of weight.

Typical of what has been done is the redesign of the earpiece for an artillery sound-locator helmet. Originally this piece was cast of aluminum alloy into metal molds and required 0.63 machine-hour for its production and 0.5 assembly-hour. Projecting from the convex surface of the earpiece was an eccentrically located, integrally cast, machined, and tapped tubular member to which the sound tube was attached. Near the edge of the casting 48 small holes were drilled to permit sewing-on a sponge rubber, chamois-covered pad.

As redesigned, the new earpiece is a sheet steel stamping covered with a low-grade molded rubber pad, and with an attached tubular member turned from steel tubing on a lathe, but suitable for ultra high-speed screw-machine production. The new piece is sturdy, light in weight, comfortable, and every bit as effective as the original model.

The trigger housing for the .30-caliber carbine was formerly made from a steel casting or forging weighing 1.3 pounds. It is now made as a steel stamping weighing 0.675 pound, and costs $2.00 as against $6.00 by the previous method. Machining operations were reduced from 36 to 14 and machining time from 40 to 7.2 minutes. For every million carbines made it is estimated that enough steel will be saved to make 135,000 additional carbines of the same type.

The files of the increasingly influential Pressed Metal Institute and of the Ordnance Department are replete with case histories like these. For example, the sight for the now-famous "bazooka" is an assembly of stampings, and its design-development set a record for speed, only 14 days (instead of the expected 60) being required. Two prime contractors were signed up; the first found five small companies to make the dies and handle the stampings and assembly. Two of these had only 8 employees, two others had 10 and one had 50. One was a tool shop on a chicken farm. The second subcontractor sublet to three concerns, one with only 5 employees.

Late in July of this year the Operating Committee on Aircraft Materials

Courtesy Lukens Steel Company

Pressing a large combustion head for a marine boiler

Conservation (a creature of WPB's Aircraft Production Board, the Army Air Forces, and the Navy Bureau of Aeronautics) announced that greater emphasis was required on conservation through improved manufacturing processes as distinct from materials substitutions. The committee cited a number of conversions to stampings that have been most economical of time, material, and cost. Savings on one order were estimated at $660,000 when an aircraft engine component formerly machined from stainless steel bar stock and tubing was converted to a sheet metal stamping.

In another case the substitution of a drawn plain carbon steel aircraft part for one machined from stainless steel bar stock reduced the material consumption per 1000 units from 285 pounds of stainless steel to only 62.5 pounds of the far less critical carbon steel. In addition, scrap production was lowered from 83.5 to 24.5 percent.

The results of the Ordnance Department's Suggestion and Conversion program to date have been evaluated by the Department on the basis of the 1943 ordnance procurement program. It is estimated that 64 million pounds of nickel, 17.5 million pounds of chromium, 5.2 million pounds of tin, and 4.3 million pounds of molybdenum will be released for the manufacture of other war material by substitution of low-alloy or carbon steel stampings for stainless or other high-alloy metals.

The three primary war-production raw materials will be heavy beneficiaries of the program, too. Substitution of steel stampings for aluminum die castings and other forms will make available enough aluminum for 25,500 fighter planes. Copper equivalent to more than three billion rounds of .50-caliber aircraft ammunition will be freed, while enough steel for the construction of 31,000 railroad oil tank cars is the estimated saving of that metal.

● ● ●

WARPED ARMOR
Plates Now Held Flat During Quenching

A MAJOR problem in heat treating armor plate—especially the light plate now so widely used—is the warping that occurs, during quenching, when the steel plate passes through its "critical" range. Overall flatness specifications are such that armor plate which has been quenched by ordinary tank or spray methods must be mechanically straightened afterwards. In many armor-treating shops that portion of the total time, labor, and expense consumed by straightening alone is the largest single item on the work or cost sheet.

To overcome this, about a dozen American armor plate manufacturers are now using a new type of "pressure quench," or some modification thereof, that automatically keeps the plate straight during the quenching process and obviates a large part of the separate straightening operations. It consists essentially of an ingenious but simple arrangement for pressing the plate uniformly on both faces and simultaneously spraying both faces with water from the pressing unit as the plate emerges on a conveyor from a continuous-type hardening furnace.

In detail, the pressure quench comprises a rugged structural steel framework with a horizontal stationary upper press platen and a movable lower platen. As the armor plate emerges from the hardening furnace it passes onto separately driven conveyor rollers, which are stopped at the moment the plate is entirely on them and located directly between the platens. The lower platen then rises and its upward projecting lugs lift the plate off the rollers and press it against the downward projecting lugs of the upper platen. With the plate in this position the quench water is sprayed out of the platens on to both surfaces of the plate. When quenching is completed, the lower platen is lowered, the plate is deposited on the roller conveyor, which then carries the plate away.

Hardness tests show an astonishing uniformity of production quality. In one case observed all but three out of 210 hardness tests on successive plates gave *exactly the same* hardness reading, and even those three were well within specification limits.

But the big advantage is the saving in straightening time and labor the pressure quench provides. In one plant this amounts to 35 percent of the total man-hours formerly consumed in the handling, treating, and straightening of armor plate. In another, 75 percent of the straightening work—itself a major part of the total fabrication—was eliminated through use of the pressure quench.

Most of the pressure quenches in use were designed and built by The Drever Company. The Ford Motor Company has built its own units along lines similar to Drever's.

PLATING PROBLEMS
Call for Exercise of Good Technology

THE WAR has simultaneously accelerated the application of science in the electroplating industry and increased the electroplaters' awareness of the formidable technical and commercial problems ahead of him.

E. W. Cochran, of National Cash Register Company, for example, expects platers to be more conserving of the vital ingredients of their baths after the war than they were before. Formerly it was standard practice to dump down the sewer used plating solutions containing 20 to 50 percent of their original metal content. Now there are available and in use resins with absorptive properties that are controllable and by which a large measure of the previously wasted bath metals can be recovered.

Chromium plating of tools, anodic treatment of aluminum, and electrolytic polishing of various metals to secure a bright finish or to remove burrs are processes new to many electroplaters and are expected to be commonplace in the post-war picture. These and others may be needed, though, to solve some of the new problems the plater will face.

Thus electroplating will find itself in competition with the new oxide and phosphate coatings that have been highly developed during the war. Hot-dipped tin may return to compete with the "emergency" electrolytic product. So it isn't going to be all clear sailing and good technology plus good business will be very much required.

A New Industrial Frontier

This Nation is Waking up to the Increased Speed and Economy of Production Implicit in the Practical Cultivation of a Variety of Supposed Theorist Hitherto Thought to be a Luxury—The Applied Mathematician. Things are Being Done About It

By FRANKLIN P HUDDLE

In the late 'twenties I heard a Commander of our Navy describe a difficult and expensive test he had recently completed on the effects of depth bombs upon the hull of a submarine. He had taken one of the obsolete "O"-Boats from an Atlantic base out to sea, submerged it, dropped depth charges alongside, and then raised it to see what damage had been caused. The inspectors risked their lives to examine the interior of the damaged submarine in the choppy waters of Long Island Sound. More recently I read an exciting narrative, written by a test pilot who risked his life frequently to determine the characteristics and performance of new designs and models of aircraft.

Although such hazardous experiments have long been regarded as virtually the sole way to learn facts about submarine and aircraft design, Europe has long used a short-cut which America, with its great wealth of raw material and time, has ignored. Many questions which we have answered by expensive and dangerous experiment could have been answered more cheaply and safely by a mathematician with experience in engineering techniques.

The United States is by no means laggard in the entire field of mathematics. To the contrary and beyond reasonable doubt, this country leads the world in the theoretical branch of the science. However, abstract mathematics has gone far beyond the scope even of most graduate engineers; almost all of them, while perfectly competent in the mathematics of known designs, are unable to take full advantage of new developments in this highly complicated, wholly theoretical, field. On the other hand, engineering science has progressed so much that the theoretical mathematician cannot easily see the relationship between the abstract formulas and the practicality of new designs.

This gap between the abstract and the concrete is bridged by the applied mathematician.

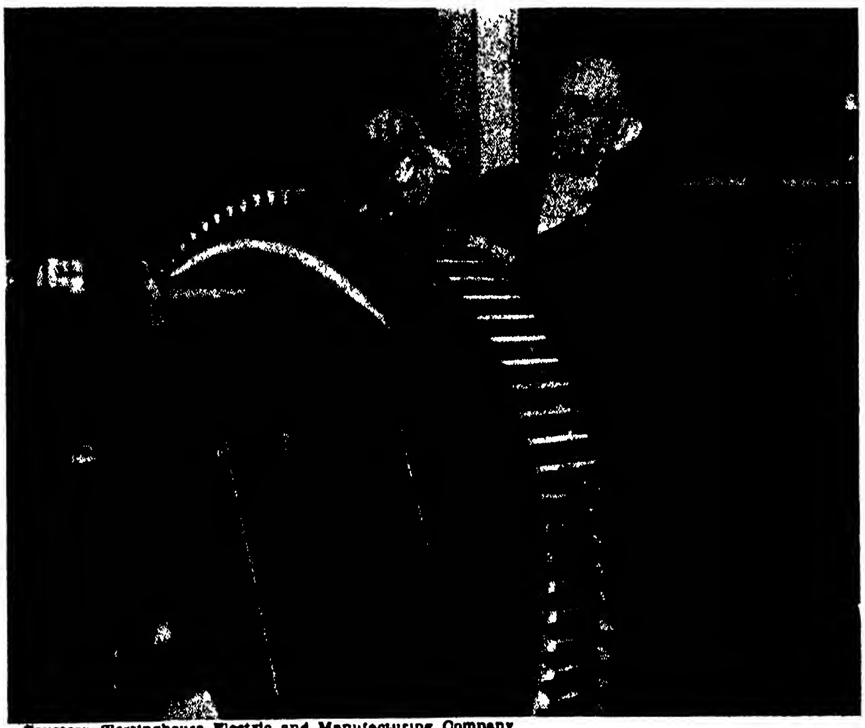
Speaking mathematically, the average engineer is versed almost exculsively in the application of familiar, prepared formulas to specific situations, and perhaps in occasionally adapting such formulas to new uses. In building a bridge or a ship hull or a conveyor system or a production line he computes by substituting known quantities within established formulas. Thus he can determine how large stringer *A* should be, how to neutralize the effect of the torque at point *D*, or how rapidly the system should pass a given point and how to build accordingly. (This description is not however, intended to imply that the engineer is a mathematical babe in arms On the contrary, he must have a pretty solid working knowledge of the subject, in order to use some of the formulas of his vocation. Most engineers themselves do, nevertheless, regard mathematics as only one of the tools of a highly varied and highly integrated profession.)

The theoretical mathematician, on the other hand, almost never relates the development of his formulas to concrete, material objects. He starts with an assumption *in vacuo* and develops its relativity according to mathematical principles. He cannot be expected to perceive the application of his ideas to reality—that would hold him down. If he can express entirely theoretical relationships he is content.

The third member of the trio—the applied mathematician—is something of an engineer and something of a theoretical mathematician. He is able to juggle theoretical mathematical relationships, yet, at the same time, he is concerned with their practical application. While working with theoretical concepts he is continually alert for ways in which they can be practically applied. This over-simplification (like most over-simplifications) is misleadng if taken too literally. Some of our applied mathematicians are perfectly competent to produce brilliant theoretical papers; the converse is also true. But such men are all too rare, and in this age of specialization perhaps it is best to speak of the departments as if they were indeed water-tight.

The emphasis of this article is that by specializing in the application of abstract theory to specific problems the applied mathematician is able, often, to answer questions that might go unanswered or might be solved only at the cost of long experimentation. America is only beginning to realize the advantages to production inherent in this subject, but it becomes increasingly true that many types of production in this country could be helped in one way or another by the services of an applied mathematician One illustration of this statement comes from the field of aircraft design.

For a number of years airplane wings were built perpendicular to the axis of the fuselage. Information about air-



Courtesy Westinghouse Electric and Manufacturing Company

Applied mathematics solves problems of production; it tells exactly how close a tolerance is needed in some kinds of products, and thus saves time and money, both of which are lost when the tolerance is set by the old method of playing far on the safe side, in order to be assuredly within the actually needed tolerance. Measuring tooth contour of high speed gears for electric locomotives

plane design was built around the premise that this principle was constant. Now, for military reasons, it has become desirable to introduce a "sweepback," so that the wing tips are further aft than is the "root" of the wing where it joins the fuselage. Necessarily this considerably changes the wing properties. A disproportionate amount of the support of a wing is contributed by the wing tips. When an airplane is about to land or take off, its tail is lower than in flying position; at that time the wing tips may be "stalled," and since this rarely happens simultaneously for the two wings, one tip is likely to droop. When this happens close to the ground and while the airplane is still traveling at high speed, the craft and pilot are in considerable danger. The airplane designer compensates for this by twisting the wing tips very slightly so that the leading edges are lower by a hair than are the trailing edges of the wing tips. Thus when the airplane is landing or taking off, with its tail low, the stalling of the wing tips will be delayed. The disadvantage of this expedient is that in normal flight position the twisted tips become inefficient. The mathematician's problem is to discover the optimum point at which the greatest flying efficiency is consistent with landing safety.

Ten or twenty years ago this problem would have been solved by building a considerable number of experimental airplanes, each with a different twist to the wings. Perhaps a portion of these would be destroyed in tests and two or three test pilots would have been endangered, but the information would have been learned experimentally. Today the applied mathematician takes the problem, develops it, and sends in his answer. The aeronautical designer follows these figures in building his planes. Models are still subject to wind tunnel and practical tests but the margin of error is diminished, and speed, efficiency, and economy of construction are increased.

Another problem in aerodynamics that is today engrossing the attention of applied mathematicians is that of "flutter," the self-excited vibration of airplane wings in flight[1]. With modern speeds this flutter problem has become much more important than it was in the early days of flying because extreme speeds accentuate its damaging effect. The result of flutter is closely analogous with the magician's shattering a pane of plate glass by sounding a single note on a violin. Wings under the stress of flutter have actually been known to disintegrate in flight. Since the premium today is on speed, this problem is an imminent one for designers and hence for applied mathematicians.

If the wing of an airplane is considered complex, then the propeller of an airplane is at least equally so. In principle the two are identical. However, while a wing progresses in a straight line, a propeller revolves in a fixed circle. Naturally, the speed of any part of a propeller blade is directly proportional to its distance from the hub.

It is an established fact of aeronautical design that wings of airplanes must be designed to reach maximum performance at the speed at which they most frequently travel. But every point on a propeller blade, when the speed of revolution is constant, has a different rate of speed. Therefore it follows that if one were to pass planes perpendicular to a line drawn from the hub of the propeller to the tip of one of the blades, each plane section must be slightly different in design from its neighbors. As a matter of fact, the section of the propeller blade near the hub is very similar in miniature to the cross-section of the wing of a slow-speed high-lift airfoil, while the tip follows quite closely the section of a high-speed low-lift airfoil. In addition, the angle of blade setting also must vary with each section of a propeller blade, such that from the extreme at the hub of perhaps 45 degrees the angle approaches six or ten degrees at the tip. Finally, the airfoil structure which is most aerodynamically perfect, is not necessarily the most sturdy in construction. It is necessary, therefore, to consider compromise of design to secure an optimum between maximum rigidity and maximum aerodynamical efficiency.

ALTHOUGH this itself is an extraordinarily complex problem, it becomes even more complex when one realizes that each propeller blade in actual flight creates a sort of "interference" for the blade behind it, and that this interference is relative to the speed pitch, and number of blades.

When one has mastered the mechanics of these problems, then one is ready to graduate to the infinitely greater intricacies of controllable pitch propellers in which the angle of blade setting of the propeller may be varied in flight. To find solutions to all these problems by purely experimental means would take a lifetime. The mathematician's approach is difficult and complex enough but it has the great virtue of relative speed and economy.

Applications of mathematical methods are by no means limited to aeronautics. A captured German submarine, recently examined by a group of government experts, revealed that it had been built to withstand the shock of a depth bomb going off relatively close to the hull. This refinement of design indicates that in the problem of submarine construction the Germans have already consulted their applied mathematicians and hold an advantage over us. Our ship designers have appealed to applied mathematicians in this country for facts about structural elasticity and plasticity to enable them to build ships more resistant to the shock of a torpedo, depth charge, or bomb explosion. In this way the applied mathematician has played a part in the "Battle of the Atlantic."

Applied mathematics has been used to solve problems of production as well as design. About 20 years ago Dr. Walter A. Shewhart, now a consultant for Bell Telephone Laboratories, developed a system known as "statistical quality

Official U S Navy photo from OWI

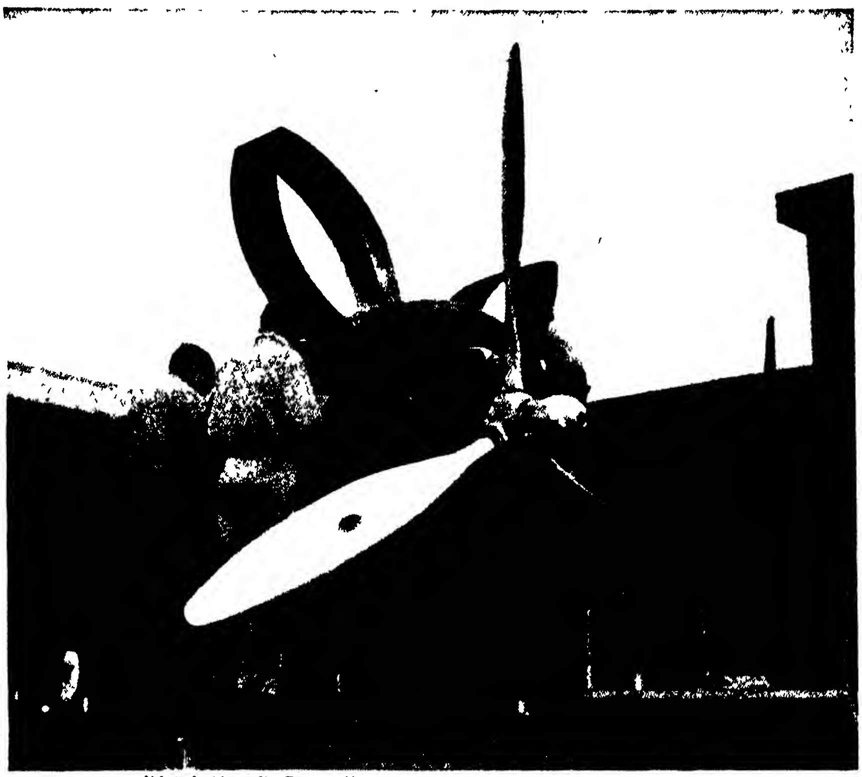
As explained in the text, when an airplane wing is "swept-back," so that the tip is farther aft than the root of the wing where it joins the fuselage, the wing properties are altered. To avoid building a whole series of experimental models, the applied mathematician works out the optimum design by theory, saving time and money. Navy's Coronado PB2Y-2, designed by Consolidated

[1]Dr Theodore Theodorsen, National Advisory Committee for Aeronautics and a member of the Brown University Advisory Committee, has worked out the fundamental mathematical theory so that not only can the "critical speed"—speed at which flutter begins—be accurately foretold, but designs may also be modified, theoretically, so that flutter will not occur within the contemplated speed range.

control." This method, which is applied to mass-production techniques, combines the statistical approach with the science of engineering to effect both economy and uniformity of production in industry.

Certain products of industry cannot be tested without destroying. A match company that insisted on testing all its products would not be much of a success. Likewise, in the manufacture of bomb fuses or explosive shells, tests must be run continually; yet, the more tests the less efficient the production. It becomes the job of the statistician to determine how often samples should be taken from the production line for testing. If too few are taken, uniformity may not be assured; if too many, the expense becomes prohibitive.

The same method is also applied to the determination of tolerances. We know, for example, that a bolt must be designed within narrow limits or tolerances in order to fit inside a bolthole. It is manifestly impossible for bolts, however precision-made, to duplicate with perfect exactness the original model. Yet how far away from the original model does the engineer dare to go? To decide such questions is important from the point of view of operation of the finished product but it is also important from the point of view of production. In practice the engineer usually plays safe by ordering a tolerance far smaller than is really necessary. If the company follows his tolerance limits rigidly, as it is supposed to do, a great many pieces will be rejected as faulty. On the other hand, if the statistician is handed the same problem, he will be able to compute what the tolerances should be to maintain the maximum degree of safety in relation to a minimum degree of spoilage. Perhaps nine tenths of the parts thrown away in response to rigid and over-close tolerances are in actuality perfectly acceptable and useful.



Courtesy Consolidated Aircraft Corporation

In principle, the wing of an airplane and the blade of a propeller are identical—each is an airfoil. Just as the wing is designed for maximum performance at a given speed, so each section of a propeller blade from the hub to the tip is slightly different in design. Here the applied mathematician outshines experiment

It is easy to see that such a process makes production more efficient, lowers the cost of the item, and increases the speed with which it may be produced. Dr. Shewhart's method is widely used in the United States, Great Britain, and Russia. The United States government has trained hundreds of people in the application of the theory at its Aberdeen, Maryland, Proving Ground and at other production centers.

A considerable impetus has been given to the development of applied mathematics in America by the social unrest in Europe, beginning in 1933. Since that time a large number of European scholars have migrated to this country to add their enormous contributions in science to the domestic product, with the natural result that the combined outpouring has elevated our own standards immeasurably. Mr. Arnold Dresden in *American Mathematical Monthly* (Aug.-Sept., 1942) lists 131 mathematicians who came to this country between 1933 and the first half of 1942. Generally speaking, America has been able to welcome and to place such scholars quickly, and to profit by a type of training which hitherto has been largely peculiar to Europe. Nevertheless, America still has a long way to go.

For a very good reason Europe is far ahead of us in techniques of applied mathematics. We have set a high value upon brains and a low value upon time and materials, while Europe's sense of values reverses these commodities. Consequently, European technicians make a practice of reducing the chance of error before they begin to build. They discovered that the possibilities of this method were limitless in extent and have made it a point of honor to develop a sound theory before experimenting with new construction designs.

Applied mathematics had its modern origin when Napoleon realized the military value of mathematical officers. The scientific work of the French in the early 19th Century was a major contributing cause to their military successes. The Germans quickly realized the importance of the applied mathematical technique and, about a hundred years ago, established institutes at Wien and Prague, based upon the original institute—L'Ecole Polytechnique—at Paris. After these two came a large number of other so-called "Technische Hochschule." The Germans explored the subject of applied mathematics with customary thoroughness. They created a number of highly specialized institutes in hydrodynamics, aerodynamics, electricity, and related subjects. To obtain the best possible instructors for these institutes they maintained a high rate of pay for the faculties. In recent years the Kaiser Wilhelm Institutes at Berlin and Göttingen, and the Aerodynamical Institute at Aachen, supported in part by the government and in part by private industries, have made great progress in industrial mathematics. As an example of the proportions: At the three institutes attached to the University of Göttingen[2], in the year 1938, fully 2000 persons were employed in aerodynamical research, including scores of mathematicians.

For comparison with this figure is a report made late in 1940 before President Roosevelt and the 77th Congress[3] by Dr. Thornton C. Fry, mathematical research director of the Bell Telephone Laboratories. Dr. Fry states that the number of mathematicians in this country employed in communications, electrical manufactory, petroleum industries, and aircraft, is estimated at about 100. He estimates that another 50 are engaged in other mathematical problems relative to production. In addition, the government employs about as many mathematicians as does private industry.

Considering the enormous industrial productivity of the United States it is truly striking that this number is so small. It is likewise extraordinary that the valuable contributions of this small group are so disproportionate to its size. According to Dr. Fry: "The group (of applied mathematicians employed at Bell Telephone) has functioned successfully for a number of years. . . . Information regarding their activities reaches management almost entirely

(*Continued on page 235*)

[2]Largest of the three is the Aerodynamic Experimental Station with about two thousand technicians The other two are the Kaiser Wilhelm Institute for Flow Research with about 50 and the Institute for Applied Mechanics with about 15

[3]The Committee on Survey of Research in Industry, appointed by the National Research Council, submitted a report to the National Resources Planning Board and to President Roosevelt. Dr. Fry's contribution is *House Documents* Section 6. Part 4. pages 268-288.

Conducted by KEITH HENNEY

Super-Sight With Phototubes

Printed Designs Moving Through a Paper-Handling Machine at High Speeds Are Invisible to the Eye, but the Phototube in a Modern Control System "Sees" these Designs and Makes Each Arrive at a Particular Point at a Particular Instant. Other Industrial Uses

By JOHN MARKUS
Editorial Staff, *Electronics*

WHEN IT comes to speed, the human eye is a piker compared to a phototube. Just watching the evening paper rolling out of a modern newspaper printing press will prove that; our eyes can't read a single line on pages moving past at such high speed, and even have difficulty in distinguishing one page from the next. The modern phototube, on the other hand, can read those moving lines of print right down to a hundredth of an inch even if they are moving past at nearly a thousand feet a minute, and can issue electrical commands which make each line or mark arrive at a particular spot in the machine with that same accuracy of 1/100 of an inch.

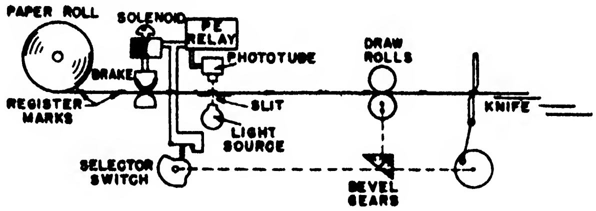
When it comes to reliability, also, the phototube wins out. Consider, for example, a man who is watching an ordinary automatic candy-wrapping machine to make sure that each piece of wrapping cut from the roll is cut between printed designs. Watch his eyes while a comely, sweater-bedecked blonde walks down the aisle past his machine. A hundred chocolate bars could be wrapped with half the design cut away during this distraction. No woman on earth, however, can make a phototube turn its eye.

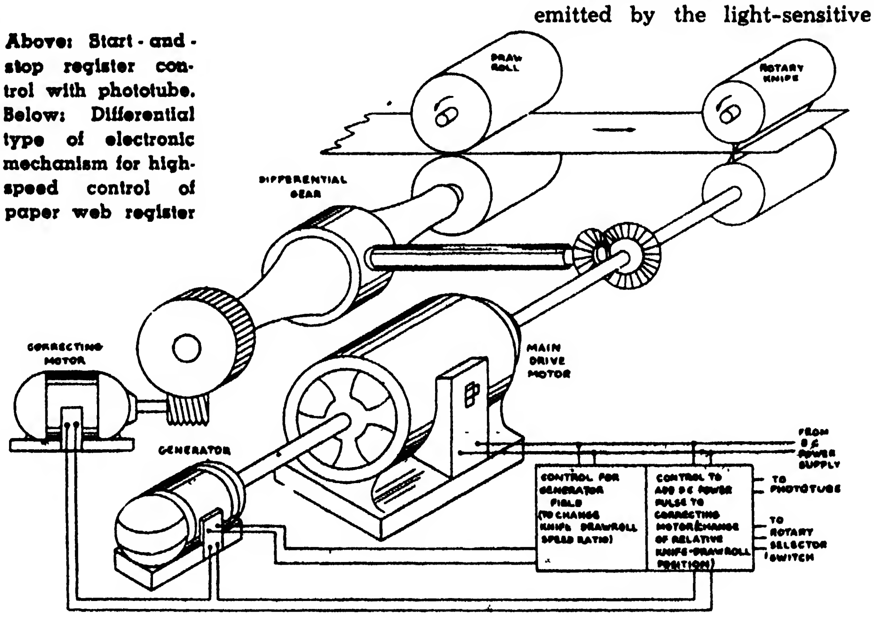
When dealing with color, your eyes now and then can put up a better all-around showing. When, however, a phototube is designed especially for a particular color or a particular job, it will respond even to those yellows or purples that might fool some other phototube. As a matter of fact, there are photoelectric units which can distinguish and identify as many as 2000 different colors with an accuracy that can be matched only by a very few of the country's best color experts.

One of the important industrial uses for these qualities of the phototube is implied in the foregoing description of characteristics—the control of high-speed motion, known technically as photoelectric register control. It applies to all machines handling a continuous web or strip of paper, cellophane, or other material, and performing some operation on that paper.

This operation may involve printing on the paper in correct relation to previously printed matter; it may involve cutting the paper between repetitive printed designs; it may involve perforating the paper with rows of holes between designs; it may involve folding at a particular point in a printed design, or any other operation that must be performed with accuracy at a certain point in each repeated section of the web.

Machines can readily move paper at high speed and simultaneously perform any or all of the above operations, but minor errors of all kinds multiply rapidly at such speeds. The slightest error in the relation between the spacing of the printing and the distance traveled by the feed roll per revolution of the cutting, perforating, or folding device can quickly cause trouble even though the machine is started up in exact synchronism. Shrinkage of paper with changes in temperature or humidity can cause just as serious errors even in a perfect machine.





Above: Start-and-stop register control with phototube. Below: Differential type of electronic mechanism for high-speed control of paper web register

To utilize the many advantages of a unit design for wrapping a product, together with the economy of printing from a continuous web of paper rather than individual pre-cut sheets, some sort of register control is absolutely essential. The form taken by this control depends upon the speed of operation and the accuracy to which the register must be held.

Starting from zero speed and no accuracy, we soon get beyond the usefulness of the human eye as a register-controlling means. Holes punched in the paper at correct positions to pass between contact fingers of an electric circuit permit greater speeds, but holes, too, have their drawbacks. This brings into serious consideration the modern photoelectric device for controlling register without even touching the moving sheet.

To furnish an understanding of this operation, one application will be followed through, with the brief explanation that the principles will apply with only minor modifications to many other possible applications. A good example is the cutoff control, as required in packaging machines to cut one complete design unit from a roll of printed paper and pass it to the ingenious mechanical mechanisms that wrap and seal this paper around such things as candy bars, sticks of gum, and so on.

In the simplest form of photoelectric register control, a small register mark is printed in the margin of the sheet at each point where a cut is to be made. A light beam and phototube are arranged side by side so that the beam is reflected into the phototube from the moving paper. Since the marks are darker than the rest of the paper, less light is reflected whenever a mark intercepts the path of the light beam. This reduces the amount of light falling on the phototube, thereby changing its electrical characteristics. (Technically, reducing the light increases the electrical resistance of the phototube because it reduces the number of electrons emitted by the light-sensitive

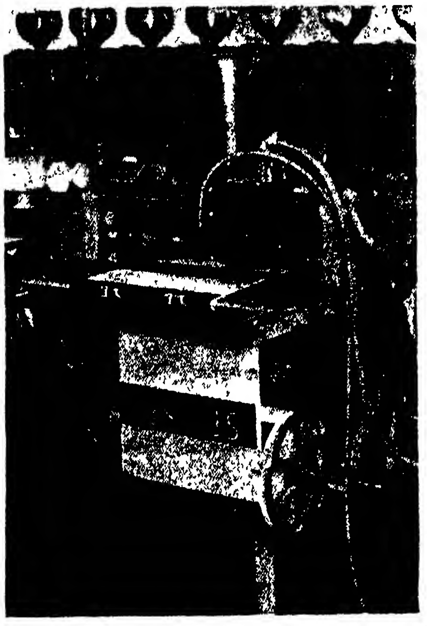
cathode of the tube.) Amplifiers respond to this change and actuate a magnetic brake that stops the paper right at that mark so it can be cut off. The brake then releases, the paper moves till the next mark is seen by the phototube, and the process repeats.

In this American Chicle Dentyne-gum packaging machine, unit 1 feeds strips of gum to unit 2, which cuts individual sticks. Unit 3 wraps each stick in a printed paper wrapper under supervision of phototube register control. Unit 4 wraps six sticks at a time in tinfoil with easy-opening tape, and unit 5 puts on the final printed wrapper, also with register control. Inset shows sample wrapping strip for individual sticks, with dark register marks, which actuate the photocells, at edges

SIMPLE stop-and-start control is all right for many applications, but not for high speeds. To get increased output, the paper must be fed continuously and cut by a rotary knife. On the knife shaft is placed a rotary selector switch with two sets of contacts. One set stays closed during part of a revolution and opens just before the knife makes its cut, while the other set closes just after the cut is made and stays closed during part of the revolution. The phototube watches the register mark go by, just as before, but now its impulse does not stop the paper. Instead, the impulse due to a register mark is fed through one or the other of these rotary switch contacts to mechanisms that cause the knife to cut a little earlier or a little later than normal, as called for by the phototube. If the register mark comes by right at the correct instant, both sets of contacts are open and so nothing happens except that the paper is cut at the correct point.

To eliminate the necessity for the photo tube to continue "looking" at a register mark while the mark is being cut, the so-called scanning head containing the phototube and light source is placed a full wrapper length ahead of the knife, where it watches one spot ahead of that which is being cut.

The knife and spot are brought into register without stopping the machine, by means of other electronic devices. Inside the control cabinet are two thyratron tubes like those used in push-button electronic motor control equipment—electronic tubes that trigger-off on an electrical impulse like that produced by the scanning head. One thyratron is connected through the too-early contacts on the rotary knife, and the other thyratron is connected through the too-late contacts. One thyratron causes an auxiliary correcting motor to move forward, and the other thyratron makes the motor turn backward, as required to produce the required correction. A simple timing arrangement stops the motor, allowing only a given amount of correction, and resets the entire apparatus so that it is ready for more correction at the next register spot, if necessary.



Photocell scanning head installed to control application of a printed wrapper to individual paper rolls

The scanning head "watches" register marks on the margin of a sheet of printing paper going through a high-speed multicolor gravure press

The correction can be made in a variety of different mechanical ways, depending upon the machine and the ideas of its manufacturer, but these fall into essentially two basic types—the compensating roll and the differential.

The compensating roll comes from rotary press practice. After passing through the draw-rolls (which pull the paper from its roll), the paper is looped over the compensating roll, then run down through direction-changing take-up rolls to the rotary knife. The thyratrons here operate a reversible motor that moves the compensating roll either up or down, to shorten or lengthen the loop of paper going over the compensating roll and thus make the necessary correction of position at the knife.

The differential drive is similar to the differential of an automobile, which permits the inner rear wheel to turn slower than the outer rear wheel when going around a curve. The differential is placed in the drive between the rotary knife and the draw-rolls. At one end of the differential shaft is a draw-roll, and at the other is a gear that can be turned in either direction by a worm gear on the shaft of the reversible auxiliary motor. When register is correct, this motor stands still, and the draw-rolls turn at the same speed as the rotary knife. If the phototube calls for a change in position, the auxiliary motor provides just the amount of the change, with the main drive motor doing all the work all the time.

The simplest differential systems are arranged to provide a definite change in the relation of draw-roll to knife for each impulse reaching a thyratron, such as 1/32 inch either forward or back as required. In higher-speed systems, however, the main drive motor is geared to drive the draw-rolls 1 to 2 percent fast through the differential when the control motor is stopped. Now, when the control motor runs at half speed, the knife and draw-rolls run at the same speed. When the control motor runs at full speed, the draw-rolls run 1 or 2 percent slow. Power for the control motor is obtained from a small generator driven by the main motor, so that this percentage ratio holds true for a wide range of speeds of the entire machine. Also, field-control means are provided on the generator to counteract the cause of loss of register automatically. In this deluxe arrangement, register may be held so exactly that a hundred cuts or more may be made before any correction is required.

Now for a few everyday uses of auto-

matic photoelectric registry control:

In Washington, the government has a rotary perforating machine that punches 3000 rows of holes a minute in sheets of stamps with an accuracy of 1/64 inch, guided by register marks printed in sheet margins to actuate a scanning head. Look for these marks the next time you get stamps with part of the sheet margin attached.

At a printing plant in New York City, four-color printing on a gravure press is registered so accurately by the phototube equipment that four different colors of dots can be struck with an accuracy of better than four or five thousandths of an inch, as required for high-quality color printing.

When dealing with cellophane, such as is often used for wrapping candy bars, the light beam is sometimes sent right through the material, with the light and phototube on opposite sides. Here again, registry spots reduce the amount of light reaching the phototube, so the principle of operation is the same as for reflected scanning.

Fitting the right photoelectric register control to a particular application is a job for a good electronic engineer. The many successful applications already made foretell an important role for this intriguing branch of electronics in the years to come, making better products at lower prices through electronic control

• • •

PHOTOELECTRIC GUARD

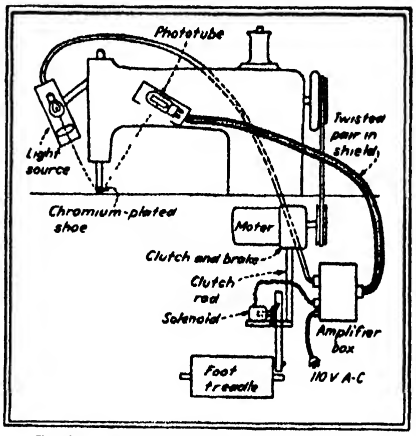
Protects Fingers of Sightless Seamstresses

To protect the fingers of sightless workers operating electric sewing machines, a photoelectric safety system has been developed by J. O. Kleber of the American Foundation for the Blind. The control system brings the machine to a complete and sudden stop whenever the fingers of the operator come dangerously close to the needle.

From the left side of the machine a beam of light is projected into the chromium-plated "shoe" of the sewing machine by a light source consisting of an automobile stoplight bulb and a lens in a tubular housing. The reflected beam is picked up by a standard phototube in a housing at the right of the shoe. The beam is thus about half an inch ahead of the needle, in a region through which the fingers of an operator might normally approach the needle.

All connections to the amplifier housing are made through four plugs, making it possible to install a new amplifier unit in a few minutes if trouble develops. This is a highly desirable feature when workers are paid on a piecework basis.

The sewing machine is a standard commercial model, in which the motor runs continuously. Pressure on a foot treadle connects the motor to the machine through a clutch and simultaneously releases a brake. Releasing pressure on the foot treadle, or equivalent "breaking" of the rod which links the treadle to the clutch, will therefore disconnect the motor and apply brakes to the machine.



A phototube system makes this sewing machine safe for the sightless

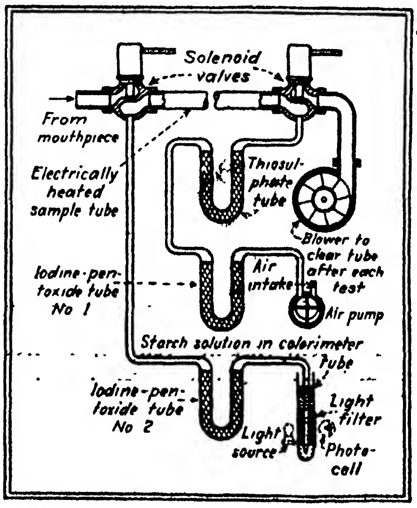
The relay in the plate circuit of the amplifier tube controls a solenoid which, when energized, "breaks" the clutch rod and thus stops the machine. As soon as the obstruction is removed from the light beam, the clutch rod can be restored by momentarily removing foot pressure from the treadle.

INTOXICATION

Indicated by Photoelectric Analysis of Breath

An electronic method of diagnosing moderate intoxication at the time of an accident or arrest has been developed at Yale University. The apparatus is fully portable, requires only a sample of air, and gives a result in terms of alcohol concentration in a few minutes.

The essential features are shown in the diagram. An exactly measured sample of the suspect's breath is collected in a glass tube that is electrically heated to prevent condensation of moisture which might contain alcohol. The exhaled breath automatically passes through a tube of iodine pentoxide which oxidizes the alcohol and liberates iodine in proportion to the amount of alcohol oxidized. The iodine is carried in a stream of warm air to a glass tube containing a solution of starch. This starch turns blue in proportion to the amount of iodine present, and a photoelectric cell indicates the intensity of the blue color on a meter in terms of percentage of alcohol in the blood.



Electronic judge for drunken drivers

The various operations are timed and kept in proper sequence by a synchronous motor, hence the test is automatic once the motor is started. To use, the operator presses the starting button. When a green light appears, the suspect blows his breath into a mouthpiece. The operator then inserts a small glass tube of solution into a holder and waits five minutes for the meter reading.

If anything goes wrong, the apparatus fails completely—an essential requirement if the test is to have legal status. It cannot give an erroneous reading. The tube of final solution can be taken into court as evidence, and can be reinserted in the apparatus at any time to verify the concentration of alcohol.

MARINE GEARS

Controlled During Balancing By Electronic Means

Automatic control of the accelerating rate in bringing 17-foot diameter marine propulsion gears up to full speed of 200 revolutions per minute for dynamic balancing is now obtainable by means of electronics. The 50-ton gear to be tested is supported by bearings which permit the gear to vibrate freely in a horizontal direction. Pick-up coils convert this movement into electrical impulses which energize a wattmeter in a dynamic balancing circuit that indicates where correction of unbalance is required.

Electronic control equipment was chosen because both squirrel-cage and wound-rotor induction motors heated excessively during the required long acceleration time of 10 minutes.

EXPLODING GUNPOWDER

Makes Record of Uniformity On Cathode-Ray Tube

Electronic testing of gunpowder to insure uniformity in production runs, and thereby to eliminate errors in fire-control calculations due to variations in propelling charges, is one of many new wartime applications for the cathode-ray oscillograph.

A powder sample is exploded in a strong sealed container, and the voltages derived from pressure elements affected by the explosion are applied to the cathode-ray tube of a Dumont type 235 oscillograph. This causes the electron beam to trace on the fluorescent screen a path that constitutes a graph of pressure variations. This oscillogram is photographically recorded and later analyzed.

The entire process is automatic once the closed container or bomb has been charged and the circuit voltages adjusted. Pressing a plunger then automatically opens the camera shutter, turns on the cathode-ray beam, fires the charge, turns off the electron beam, and closes the camera shutter.

Conducted by The Staff

Packaging Delivers the Goods

Protection Against Heat, Cold, and Humidity, Mildew, Insects, and Vermin Is Demanded for the Safe Delivery of Supplies to Our Troops all Over the World. Developments to Meet these Rigid Requirements, Made by the Packaging Industry Will Carry Over into Post-War Days

By STEVEN M. SPENCER
E I du Pont de Nemours and Company, Inc

GETTING the goods to the fighting front and to our allies is one of the war's most challenging tasks. It involves not only the problems of transport over crowded rail lines and through submarine infested waters; it requires also the strongest, toughest, most weather-proof packages ever produced, and these in tremendous quantities.

Supplying these, despite shortages of steel, tin, and rubber, has brought about something of a revolution in one of man's oldest industries. And to a certain extent it has meant a return to first principles, a shift from eye-appeal to solid utility.

Roots of the packaging industry go far back into prehistory. Crude clay pots came soon after the stone hand-axes of the Old Stone Age. Those of the Middle Stone Age even had painted and engraved decorations, a primitive concession to eye-appeal, perhaps, but not one which subordinated the main function of a container, the protection of its contents—wild grain, fruits, nuts, perhaps dried meat.

Some authorities believe that basket-making antedated pottery, that it may have been the earliest human industry. Because of their perishable nature, however, no baskets from the Stone Age have been found. The earliest ones that can be approximately dated are the large round grain baskets of Egypt, from 4000 to 5000 B.C.

Even the impregnated fiber materials of today's water-proof containers had their ancient prototypes, including one of the most famous baskets in history. For it will be recalled that when the mother of Moses could no longer hide the infant "she took for him an ark of bulrushes and daubed it with slime and with pitch and put the child therein." And the basket floated along the edge of the Nile.

But today's packages must withstand much more than the slow-flowing waters of Egypt's ancient river. Food, machinery parts, guns, bombs, ammunition, clothing must be packed in boxes than can be unloaded at Pacific Island destinations which boast no wharves, docks, or warehouses. Many of them are simply dumped into the ocean and landed by the tides or hauled up on the beach by soldiers and natives. Sometimes they must stand in the sun, buffeted by the waves, until men busy with fighting can take time off for stevedoring.

The heat and humidity of the tropics (which may be even more penetrating than the ocean water), mildew, insects, and vermin—these are other enemies which America's packaging industry is called upon to battle. And at the other end of the climatic scale is the North Atlantic, and the routes over the Scandinavian shoulder to Russia's Arctic gateway.

A general idea of the conditions these wartime packages must meet can be obtained from two sentences taken from an Army officer's description of an ideal package:

"The case should withstand a temperature of 100 degrees, Fahrenheit, and 95 percent relative humidity for at least 20 days without appreciable effect on the packaging or contents. The case and contents should withstand dropping twice on each flat surface (it had previously been dropped to a concrete floor once on each of two diagonally opposite corners, once each on all six edges and twice on each face) after being stored at 0 degrees, Fahrenheit, for 48 hours without the packages being appreciably damaged."

This, then, was the problem tossed in the lap of the nation's $4,000,000,000 packaging industry which had progressed from the pottery and basket age up through the cracker-barrel and sugar-sack era to the sophisticated modern period of cellophane, multicolor printing, and transparent plastics.

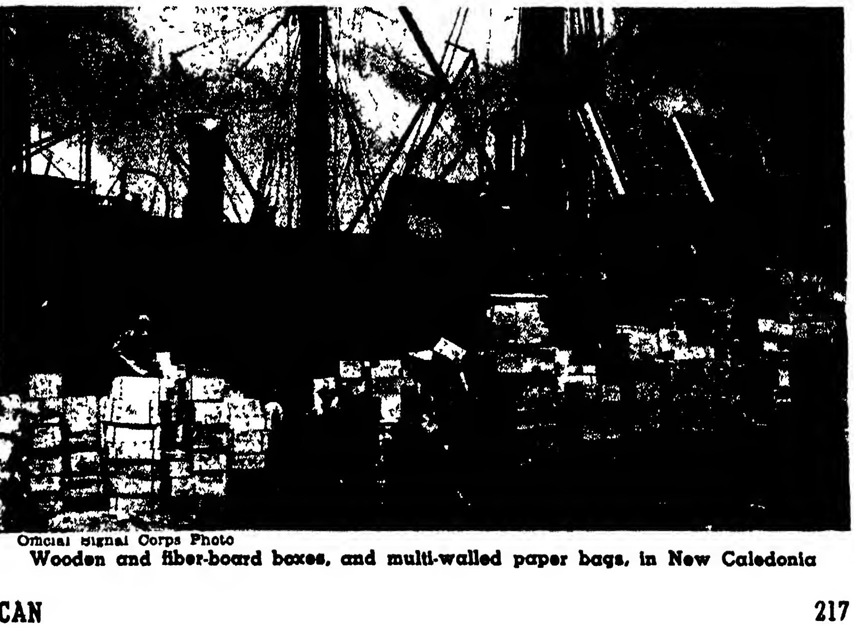
One of the first principles of 20th Century packaging has been attractiveness. The container was designed to induce people to buy. The accent was on merchandising, with protection of the contents more or less taken for granted.

If the package held up under normal conditions, it was considered satisfactory. But the war put all emphasis on protection and subordinated beauty and salesmanship, particularly in military and Lend-Lease goods and to a somewhat lesser extent on products for civilian sale.

Steel was reduced in military packaging and, except for very special purposes, was out of the civilian picture. So was tin. Rubber could be had only in limited quantities. Plastics were needed for more specialized war uses. This left glass and wood as the main raw materials for the nation's containers. And wood has performed yeoman service, indeed, not only in the form of boxes, crates, and barrels, but in the many products made from wood pulp including cellophane, paper, and fiber-board.

Cellophane, which at the time of World War I was a luxury item reserved for such glamor roles as wrapping expensive perfume bottles and candy boxes, had in the intervening quarter century become widely used to protect food from moisture loss or moisture penetration as well as from dust and germs. But in most cases it was still the package you could see through and for that reason its great popularity rested to a large extent on eye-appeal as well as on protection

Today cellophane has put aside glamor to perform important war tasks in which its utility is the first consideration. Very often it is laminated to an opaque material—kraft paper or fiber-board—and its transparent properties are entirely lost sight of. It is the moisture-proof and grease-proof layer of the package, and the other materials



Official Signal Corps Photo
Wooden and fiber-board boxes, and multi-walled paper bags, in New Caledonia

are used to supply body and strength. Thompson sub-machine guns, Garand rifles, Browning automatics, are being wrapped in a laminated material, including cellophane and paper or scrim, impregnated with highly moisture-proof waxes. The wrap is heat-sealed at the edges and the guns are placed in wooden boxes. Only a very light coat of oil is needed, beneath this rust-proof wrapper, instead of the thick coating of grease formerly used. The new style of gun wrap thus obviates hours of tedious de-greasing, and the weapon is ready for immediate use at the front.

Replacement parts for aircraft, tanks, trucks, and ordnance—all of which must be protected against rust-produc-

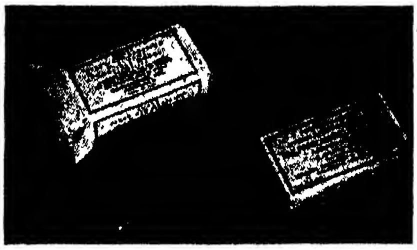
ing moisture on the high seas and in the humid tropics—are even more painstakingly packaged. One widely used method is to wrap the part in one of the laminated cellophane materials just described, then dip it in a special wax, place the wrapped and dipped article in a strong fiber-board container, wrap the container with the laminated material, dip the wrapped container, and finally place this in a second fiber-board container, which is then sealed with cellulose tape. Pistons and connecting rods are among the many articles given this multiple protection against rust ond corrosion. Replacement parts for high-speed motors must fit with extremely close tolerances, and the damage which could be done by a spot of rust makes all too plain the need for such super-care in packaging.

Many parts are placed in transparent cellophane bags, some carrying the name and number printed on the front, for easy identification during assembly in the factory.

To safeguard whole airplane motors from damage by moisture they are wrapped in transparent rubber film, with bags of silica gel tucked about inside to soak up any moisture that may be present during packaging. Chemical moisture indicators are also placed within the bag to reveal at a glance when the moisture content has become too high.

In the food field the packaging revolution perhaps reached its height; the restrictions on tin, steel, and rubber have necessitated sweeping changes. Paper, fiber-board, and cellophane have been brought prominently into the picture. In the packaging of Army emergency rations, cellophane is being widely employed for sealing in the moisture content of some components, such as the fruit bar and cigarettes, and keeping excess moisture out of others, such as the biscuits, D-bar (enriched chocolate), powdered bouillon, and lemon juice. Several of these items then go into what is termed, the K-bag, a double thickness material, frequently consisting of two layers of cellophane laminated together. All of the components are packed in two cardboard boxes, one in-

Left: Quick-frozen beans packed in a cellophane-lined fiber "can." Above: Heat-sealed cellophane protects chocolate bar and fruit bar, parts of Army "K" rations. Right: Precision parts and dehydrated carrot-juice cocktail in printed, transparent envelopes. Below: Dressings and medicines packed in moisture-proof, sealed wrappings. All photographs courtesy Du Pont Company

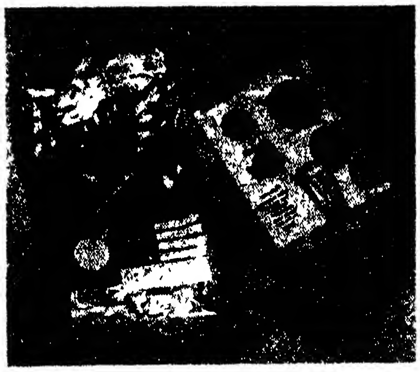


side the other, and the whole package is then wax-dipped, to give extra moisture protection.

Lend-Lease and Army export shipments of dehydrated food are usually packed in fiber-board boxes, and are often given extra protection against moisture through the use of a wrapping material made of cellophane, lead foil, and asphalt-impregnated kraft paper, laminated together. Vegetable shortening is being carried aboard Navy vessels in grease-proof cellophane bags inside fiber-board boxes.

A new step which has created much interest in the food field, and which is being tested by Lend-Lease and Army authorities, is compression or de-bulking of food. The method, which squeezes out space-consuming air, not only saves 30 to 75 percent in precious cargo space but greatly simplifies the packaging problem. Metal is not needed, and smaller amounts of other materials are required because of the greatly reduced surface area. The little cakes and bricks of "nutritional ammunition" can be easily and rapidly packaged in standard cellophane wrapping machines, which heat-seal the film. Individual units are then boxed in fiber-board containers. Potatoes, ground meat, dried eggs, whole cranberries, diced or sliced carrots, beets, onions, and a variety of other foods have been prepared in this manner. A package the size of a small shoe box will hold enough meat for servings for 100 men. The food is quickly reconstituted or "freshened" in hot water and is soon ready for use.

Throughout the war packaging picture the fiber-board cartons, some corrugated, others solid, are doing an excellent job. In has been estimated that approximately 7,800,000 tons of paperboard will be used this year in the manufacture of these versatile shipping cases, cartons, and other types of fiber containers. One of the interesting developments in this field is a paperboard containing an inner layer of jute impregnated with urea-formaldehyde resin, which makes a very waterproof carton that has withstood long immersion tests. The Marine Corps exhibit at the recent Packaging Exposition in New York showed how a carton



made of this new material and containing some light material, such as clothing, could serve as an emergency life-buoy in case of shipwreck, supporting one or two men in the water.

When the tin can and, later, ordinary black-plate metal were ruled out of the packaging picture, paper-board "cans" came in for packaging many consumer foods, from baking powder to shortening, syrups, and toothpowder. The paper-board is in some cases laminated to cellophane or glassine, or is coated with a water-proofing material such as wax. A sealed cellophane bag inside a paper-board box is a popular food packaging combination.

Glass is another replacement material that has found extensive wartime use. Most of the household-size paint items have had to shift from metal to glass jars. Coffee, fruits, and many other food products have also gone into jars. No sooner had the food industry expanded its use of jars than it found itself faced with a shortage of metal for tops, and of rubber for sealing rings. This has meant more shifts, and today some of the coffee jars are capped with stiff paper-board tops, impregnated with wax and sometimes given an outside seal with cellulose bands. Special gasket compounds for sealing had to be worked out. Jars of shortening are in some cases sealed with a cellophane drumhead to prevent oil absorption by the paper-board lid which fits over it.

In the bulk packaging field the shortage of steel for drums forced many products into wooden barrels, which also became short because of the difficulty of obtaining staves, and then into fiber drums. The demand for these far exceeded the supply. While the industry made only 3½ to 4 million fiber drums in 1941, it had stepped up its output by

early this year to a 12,000,000 per annum rate. There is an anticipated demand by paint, petroleum, chemical, and food industries, however, for some 30,000,000 fiber drums this year.

Cotton has replaced burlap, which comes mainly from the Far East, in much of the bulk packaging. Combinations of cotton fabric with water-proofed crinkled kraft paper linings have been widely used. Finally, multi-walled bags, all of paper, some treated with water-proofing materials, have found important use.

The American packaging industry has indeed been hard pressed by the greatly increased need for its products and the drastically reduced supply of raw materials required to make them. But with typically American ingenuity and resourcefulness it has drawn upon home-grown ingredients to fashion stronger, better packages in which to deliver the goods around the world.

There is no question, packaging authorities believe, that the new emphasis on protection of the contents will carry over to peacetime economy, with resulting conservation of shipped goods and greater satisfaction on the part of the consignee and the ultimate consumer. Development of new and satisfactory packages of paper-board, cellophane, and other organic materials is also expected to have wide post-war influence, saving metals for other uses and saving shipping weight as well.

British Official Photo

Women in an English Ordnance Depot removing American-made revolvers from paper and fiber-board protective transportation packages

Designing the container to catch the consumer's eye and persuade him of the desirability of the contents, is a packaging principle that will prevail in the post-war period, but the war-time lessons of protection will not be forgotten. The post-war package will not only proclaim the worth of the product; it will insure it in many war-tested physical ways.

⊕ ⊕ ⊕

PLANT HORMONES

Now Used in Dusting Powder for Seeds

CONTINUED research on the use of plant hormones (growth-promoting substances), first reported in these pages in the issue dated November, 1941, has revealed that these substances can be stabilized in seed-dusting powders as well as in the fertilizer form previously described.

While hormones in the fertilizer (Hormo-Fert) are of greater benefit to growing plants than hormone seed treatment, experience has indicated the value of Hormo-Fert Dust for seed and root treatment of seedlings.

The joint use of hormones in the foundation fertilizer and in dust on the seed gives the plant a more complete and closer coverage of hormones with consequent better growth stimulation. One method supplements and reinforces the other. These two methods were jointly used during the past season on nearly 300 acres of barley, wheat, rye, and oats with markedly better results than by using one method alone.

Hormo-Fert Dust is a fibrous organic powder with the properties of a fertilizer plus extra growth substances, or hormones, evenly distributed throughout its mass. When dusted on seed or roots of seedlings, it promotes a quicker growth and better root system. Rougher seed, like barley, or oats, may be dusted successfully with dry dust. On smooth seed, such as corn and soybeans, the seed should first be slightly wet and then rolled in this mixture so as to secure a more complete coverage.

Seed dusted with the dust grows stronger roots than untreated seed. The treated seed grows faster and, it is reported, the plants will better withstand severe climatic differences—drought and heavy rainfalls. Not only are stronger roots and plants developed but there is a greater and earlier yield of bloom, seed, and fruit.—*Lionel Weil.*

Left to right: Fertilizer without hormones; Hormo-Fert; Hormo-Fert and seed dusted with Hormo-Fert dust (dry); Hormo-Fert and seed dusted wet. All are same age

SIMULATED SUNLIGHT

New Generator Used for Testing Purposes

DEVELOPMENT of a "simulated sunshine generator," which for the first time closely approximates standard summer sunlight through a combination of 15 lamps of various spectral energy emissions, is announced by the Hanovia Chemical and Manufacturing Company. One of the first units produced is being used successfully by the Folmer Graflex Corporation to test the light-tightness of photographic apparatus being manufactured for the armed forces.

Other applications for this light source are accelerated fading, aging, and weathering tests, such as are conducted in many industries, for dye stuffs, paints and varnishes, roofing materials, textiles and rubber, or wherever materials are involved that should be tested to determine the influence of sunshine.

Simulated sunshine generator

The 15 lamps in the unit are a combination of four S-4, ten H-5, and one 1000-watt tungsten incandescent lamps. They are mounted on a chromium reflector so that the radiation covers an area of 1256 square inches.

AIR-CONDITIONED SUBS

Now Possible With New Fluorine Refrigerant

AIR-CONDITIONING of submarines is now possible through the use of a non-toxic, non-explosive fluid, called "Freon-12" fluorine refrigerant, which is non-poisonous, has no odor, and will not support flame. It does not explode should it come in contact with a sub galley's electric stoves, nor does it interfere with the chemicals which purify the air.

Air-conditioning equipment employing this refrigerant assures submarines fresh, cool air after long submersion. The men aboard the underseas vessels

so equipped can even smoke. This was an impossibility in other days when the precious air supply was carefully guarded against fouling.

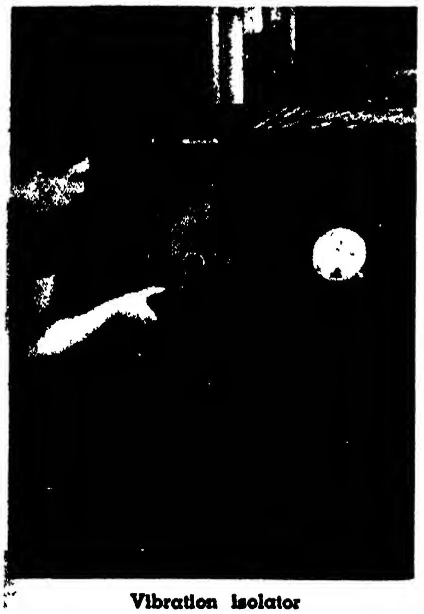
When a submarine surfaces in the South Pacific on a hot day, this modern equipment keeps the interior cool and comfortable. Furthermore, the machinery is of the reverse-cycle type, so that it can be "run backwards" to warm the air when the vessel is operating in cold weather.

"Freon-12" is one of a series of refrigerants made from the basic raw materials of carbon, chlorine, water, and the mineral fluorspar.

TEST STAND

Permits Checking Motor Vibration to Close Limits

A SIMPLE device for testing the vibration of an electric motor to standards of balance agreed upon by the National Electrical Manufacturers Association



Vibration Isolator

has been devised by the Reliance Electric and Engineering Co.

Although NEMA recognizes only commercial balance, many manufacturers set three classes of allowable vibration for a motor, which are termed commercial balance, dynamic balance, and precision balance. For the proper measurement of vibration within the limits defined for each class, it is recognized that the motor must be isolated from surrounding conditions by means of an elastic mounting; otherwise vibrations from the building, surrounding machinery, or the test rack itself would be "reflected" in the readings taken.

The elastic mounting devised by Reliance engineers utilizes four rubber columns depending from the triangular cap plates of angle-iron corner posts rising from a base plate like the four legs of an upside-down table. The test plate or mounting is attached to the other end of the rubber columns. The columns are secured to their supports and to the plate itself by means of nuts which fit onto threaded inserts bonded into the rubber.

Since rubber columns of different thickness are required in order to give the proper degree of isolation to motors of different weight, three test sets are provided to accommodate motors ranging from 1 horsepower to 200 horsepower.

Every motor produced at Reliance is given a regular commercial check which permits, for example, an amplitude of vibration of .001 of an inch in a 1 horsepower motor. It is noteworthy that this minimum standard was a maximum degree of balance only five years ago.

Purchasers often call for dynamic balance specifications, which would permit an amplitude of vibration amounting to only .0005 of an inch in a 1 horsepower motor. Precision balance, the final classification, would allow only .0002 of an inch vibration in the same motor.

With the motor running under power on the test plate, as shown in the illustration, a pick-up or probe is used to take readings from the frame, bearings, and mount. The dial of the Televiso Vibrometer shown in the picture will indicate amplitudes of vibration of less than .0001 of an inch.

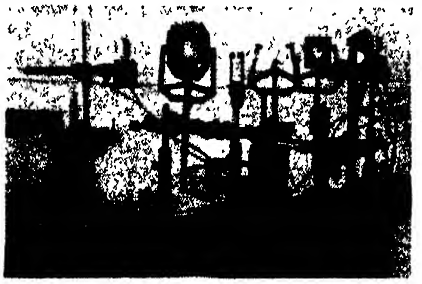
OPTICAL SYSTEM

Quickly Set Up With Adaptable Magnets

SETTING up and adjusting a standard optical system, with its maze of metal clamps and rods, has been considerably simplified by the use of the alloy alnico, made into magnets and inserted into the base of the standards. Whereas it often required several minutes to adjust the various lenses or light sources, it now is but a matter of seconds to move about the magnetic standards to the desired locations. Similar systems are applicable in other laboratory and research department work.

This new method was devised by Norman F. Barnes of General Electric's laboratory in Schenectady. All that is required is a metal top to the table on which the system is placed, and metal walls, if a vertical set-up is desired.

"Getting the proper dimensional adjustments with the old type optical system was often a tedious job," according to Mr. Barnes. "The slightest movement would throw the entire system out of adjustment and this often occurred when you attempted to tighten a holding screw on one of the standards. And if you required a vertical system, it was a real job to get the various lenses into proper line by clamping them onto wooden or metal



The present type of optical system with metal runway, clamps, rods

Same optical set-up as at bottom of page, but using magnetic system

uprights. With the alnico standards, it's no trouble at all. The standards stick wherever you place them.

"There is plenty of alnico for war jobs but until the war is won, it's not going to be an easy matter for persons or laboratories to get alnico stands for such purposes. But once the war is over, it will be quite a different matter. Such magnetized systems promise to become extremely popular."

GLASS TANK USES

Are Spreading Rapidly in Many Industries

ONE of the most important advances in the glass industry has been the recent development of glass tanks or vats for industrial use, according to R. B. Tucker, a director of the Pittsburgh Plate Glass Company. Dozens of industries are turning to glass for their tanks, and the installation of new tanks and the relining of existent units with glass is increasing rapidly, says Mr. Tucker. Because the glass used for these tanks is tempered and strengthened, making for permanency, he believes the acceptance of readily installed glass tanks will be widespread in the post-war period.

"The development of the glass tank has opened new avenues for us," Mr. Tucker declares. "The progress made in this field during the past 12 months and the interest displayed by industry has been remarkable. Obstacles faced in procuring materials worn by the increased volume due to war production has created a definite interest in glass tanks. That interest is increasing constantly and the post-war years should see even greater production of readily installed glass tanks. Glass tanks are in no way to be considered as temporary. They are made strong enough and resistant to quick temperature changes, by a special tempering process which assures tanks that are permanent."

Pittsburgh officials are enthusiastic regarding their new product, which can be fashioned in many shapes and sizes. They point out that the glass is impervious to acids, alkalis, and liquids of almost any type. Glass tanks are of high tensile and compressive strength, and are said not to rot. They are also non-absorptive and non-porous, and present a hard, level, sanitary surface requiring practically no maintenance. Standard tanks are built of opaque Carrara structural glass or of clear plate glass where transparency is desirable.

The tanks are manufactured complete

at the factory, but if new linings are required for existing tanks, crews of installers move into plants for the relining of tanks previously utilizing copper, rubber, or other materials now curtailed by war demands.

PACKAGE "EYE-APPEAL"

Increased by Attention to Color and Shape

THE MEN who design the packages for soap, breakfast foods, and other products pay great attention to the relation of color and shape to eye appeal, says the Better Vision Institute.

Most companies selling packaged goods to the public have redesigned their containers in recent years so as to obtain better color combinations and greater legibility of names and trademarks, thereby facilitating easier retention of the pictures of packages in the public's memory, and quicker identification of packaged goods on the shelves of retailers. Designers have given special consideration to shape of containers. Boxes that are long and narrow seem to contain more than those that are low and wide, thus leading consumers to believe that they are getting "more" for their money. This optical consideration is one of the chief reasons why most containers of packaged goods are oblong. Bottles containing perfume, catsup, and so on, have their height greatly exaggerated to create the illusion that they contain more of the goods than they do. Through the adroit use of long lines of type, eye-carrying designs, and colored stripes, many packages take on greater size in the eyes of consumers.

FOLDED HOUSE

Can be Used Where Pre-Fabricated Units are Impractical

MOST mobile and soonest available housing unit for the armed forces or the Red Cross is the "suitcase house," which can be made ready for use three minutes after arrival at the site.

Shipped folded into a "suitcase" less than 26 inches thick, 8 feet wide, and 16½ feet long, the basic model of this house opens to provide 250 square feet of floor space. It weighs less than 2500 pounds.

There are almost unlimited possibilities for modifications of this unit, including variations in size, double-wall, all-steel, air-tight, or windowless construction. It utilizes an accordion-opening technique developed by William B. Stout, noted industrial designer, for which the Palace Corporation has exclusive manufacturing rights.

Ready for use in five minutes

A house in a "suitcase"

The house is designed for transportation by plane, truck, or rail, and can be shipped overseas in quantity to points where material or labor shortages make construction or even assembly of prefabricated houses impractical.

The exterior on the basic model is Homasote, and non-critical lumber is used throughout. The only metal is in joining parts, wiring, and screens. Built on assembly lines, it requires fewer than 50 man-hours to complete.

Contemplated and applied uses for these units by the armed forces include field kitchens, first-aid stations, aviation repair shops, photographic laboratories, and communications and supply offices.

HIGH-SPEED CAMERA

Used in Studying Motions in Industry

ONE hundred and sixty times quicker than a wink — eight thousand "winks" a second — is the speed at which a new movie camera can photograph the split-second action of our high-speed war machines.

Using 8mm and 16mm film — sometimes at the rate of 70 miles an hour — and appropriately called the Fastax, this new camera is driven by its motors at a top speed of 8000 frames a second — an exposure period of 33 millionths of a second — making it an invaluable tool for the research engineer. This speed means that the Fastax can photograph action far too fast for the ordinary slow motion camera. It means that "movies" made with the Fastax and projected in slow motion can lay bare the innermost secrets of mechanical parts moving at lightning speed — that it can even "slow down" electricity itself. Thus the Fastax, developed by Bell Telephone Laboratories, and manufactured by Western Electric, has revealed to engineers frailties in communications and other equipment never before beheld by the human eye.

The first time the Fastax camera was used to make research films, it revealed a heretofore undetected cause of false signals in telephone equipment. In an investigation of the action of signal relay devices used in the transmittal of telephone messages, the all-seeing lens reported that a rebounding of the movable part of the relay after initial contact sometimes caused this annoying malfunction.

Bell Telephone Laboratories' scientists have made such diverse cinematic studies as the action of the vocal cords in producing speech and the explosive short circuiting of wires carrying heavy currents of electricity.

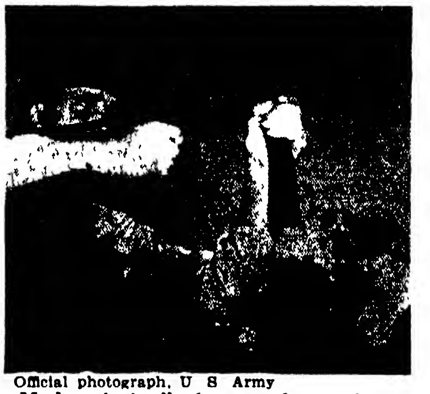
The Fastax camera is marked by its versatility — a film travel ranging in speed from less than three to almost seventy miles an hour, adaptability to black and white and color photography, and the photography of self-luminous objects. The slower speeds have been invaluable in determining stress and impact conditions of new equipment designs under test—color, black and white, and polarized light pictures having been taken of these tests. The middle speeds (1500 to 4000 frames per second) have been used to study automatic operations, to record laboratory-controlled breakage of parts and the causes of noisy operation in machines.

The Fastax employs continuous film drive, as distinguished from the stop-expose-advance cycle of the professional and amateur slow-motion cameras. Exposure of successive "frames" in the camera is accomplished by a revolving prism acting as an optical compensator. Hence the images travel in synchronism with the film past the film gate during the exposure period.

SUBMACHINE GUN

Redesigned to Save Materials, Cost, and Tool Requirements

ONE OF THE most outstanding developments resulting from the program of redesign for materials' conservation, inaugurated by the Ordnance Department of the United States Army, responsible for the development, manu-



Official photograph, U S Army
Made principally from steel stampings

facture, procurement, and maintenance of the soldier's fighting weapons and his vehicles of transport, is a submachine gun of revolutionary design, called the "Riveter" but standardized by Ordnance as the M3. The experimental model was produced and accepted for test within four months' time, and these tests proved that the new design had extraordinary possibilities. Of .45 caliber, it weighs only eight pounds (less magazine) and is so small that, when taken down, the parts will fit into a soldier's pockets. It can be used as a full automatic for rapid fire or as a single shot weapon.

A material reduction in critical manufacturing operations was effected in the redesign of this weapon. There are only 25 component parts and 73 pieces (less magazine). Instead of hogging and machining the parts out of heavy steel forging, thereby utilizing critical machine tools and creating much scrap metal, manufacture is principally from steel stampings. In fact,

all parts except the bolt and barrel are made from such stampings. Not only does this free many machine tools for other uses and eliminate much of the waste scrap but it also puts the manufacture right into metal fabricating shops equipped with power presses that were heretofore unable to obtain war contracts. (See also article on pressed metals and their present-day industrial applications, page 208. *Ed.*)

The M3 submachine gun was in production in less than six months from the time the first experimental model was tested. This engineering triumph was achieved in spite of the fact that the gun represents a complete and radical departure from all other models. Fifteen years ago the approximate cost of machine guns was $200 and under mass-production this price had been cut to something like $40. The present M3 submachine gun is being made for less than $20 and with a 50 percent reduction in man hours and 25 percent cut in machine tool requirements

The stock of the new gun is skeletonized and can be slid onto the gun proper so that the arm can be used either as a gun or a pistol. The barrel is only eight inches in length and no tools are necessary when assembling.

The new M3 submachine gun has received many tests by various service boards, and is reported to have been acclaimed as superior not only to those of the Axis but also to other American and Allied submachine guns.

RUST PREVENTERS

Aid in Salvaging

Normandie's Equipment

Since the beginning of salvage operations on the great Navy transport the *Lafayette*, formerly the French Line luxury ship *Normandie*, a petroleum specialty group which has the unusual property of displacing water from metal surfaces has been used to protect the vessel's fittings and machinery from the heavy loss which would otherwise have inevitably occurred from rusting.

The petroleum specialty is actually a series of several rust-preventing products, two of which have been used on the *Normandie*. These products penetrate water in contact with metal surfaces, spread out on the surface so as actually to push the water away, and effectively seal the metal from oxygen.

As soon as it was decided to salvage the ship after she had burned and turned over in the Hudson River, the use of the rust-preventives was suggested to officials of Merritt-Chapman and Scott Corporation, conducting salvage work for the Navy. As a consequence, equipment removed from the great ship, as she was stripped to lighten her, was washed in one of the rust-preventives before being stored for later use.

When water began to be pumped from the hull, new problems were presented, and an entirely new type of the rust-preventive was developed for protecting the machinery deep in the ship's interior. This product had the same water-displacement properties as the product used for parts removed from the ship, but was changed in such a way as to avoid fire hazard when using an oil product in the ship's enclosed spaces.

As the level of the water inside the hull was lowered by pumping, the ship's tremendous turbines and other machinery were sprayed with the new rust-preventive as they were exposed to air. As a result, it is understood that the only turbine which will show substantial damage from corrosion is one which was alternately in water and in air, due to rise and fall of the tide, before it was possible to treat it.

Standard Oil (N.J.) technicians point out that little rusting ordinarily occurs on metals which are as deeply submerged as was most equipment of the *Normandie*. Rusting does not take place except in presence of oxygen, and the oxygen content of water decreases rapidly with increase of depth. However, as soon as long-submerged metal is brought to the surface, it is attacked by oxygen very actively. Then rusting occurs at an almost visible rate.

Much of the *Normandie's* equipment was of such nature that it could not be readily dried. Encased or complicated machinery, for example, could not be disassembled promptly enough to be protected from rust in the usual ways. It was for this reason, and because of the more certain protection, that equipment was dipped, swabbed, or sprayed with one of the two types of rust-preventive.

Even electric motors were so treated,

although ordinary oils are injurious in motor armatures. As a preliminary test, a motor was treated with the more volatile rust-preventive and stored. At the end of a week, the rust-preventive had evaporated, and the dried motor was started and ran.

The ship's gyroscopic compass, a delicate and complex piece of equipment, was so successfully protected that replacement of only two parts and motor was required. It was then installed in the vessel after being taken from its long soaking in the depths of the river's muddy water.

In addition to main turbines, motors, and gyroscopic control devices, the equipment treated with the rust-preventive included hundreds of tons of pumps, lamps and lighting fixtures, kitchen utensils, laundry equipment, ice machines, and a variety of other mechanisms.

By preventing destruction of these materials from corrosion, a quantity of critical materials, and innumerable man-hours of manufacture have been saved, and the return of the *Normandie* to service has been greatly hastened.

INDUSTRIAL CORNCOBS

Main Uses to Date are Based on Physical Properties

A GREAT many industrial uses have been proposed for corncobs and, although the subject has already received a considerable amount of attention, further studies are being made by the Northern Regional Research Laboratory. The small industrial utilization of cobs is attributed more to economic factors than to a lack of knowledge as to the means for preparing useful articles, chemicals, or chemical derivatives from them.

Since cobs, and most other agricultural residues, waste wood, sawdust, and so on, are of similar composition, chiefly cellulose, hemicelluloses, and lignin, together with ash and small amounts of nitrogenous and soluble materials, they are competitive waste materials from the standpoint of composition. The permanent use of any specific residue for any desired service will, therefore, be based on the greater suitability, as regards other factors, of that residue to perform such service. Because of their physical characteristics, particularly because of the hard, tough nature of their woody portion, ground cobs have found use in industry for certain special purposes. Such uses, up to the present, are based entirely on their physical rather than on their chemical composition.

Ground cobs, for some 20 years or more, have been marketed for the purpose of cleaning furs, for burnishing metals, for removing oil from tin and other types of metal plates, and for making sweeping compounds.

Ground cobs of about one-quarter to one-eighth inch in size make a very suitable fill in farm and other buildings for heat insulation because of their low thermal conductivity. They may be used as a loose fill over ceilings

between the joists or in walls between the studding. However, they have the disadvantage of not being fireproof, and while they do not attract vermin, they are likely to be a good harbor for them because of the looseness of the fill.

Ground cobs have been used in making light-weight ceramics and tile. The procedure consists of incorporating in the clay particles of cobs which, on burning, leave empty air spaces. Many types of ground ligno-cellulose materials will perform the same service.

Ground cobs seem to be suitable as a filler for plastics, except that the luster and waterproof qualities of the phenolic plastics made with cob flour do not seem to be as high as with wood flour. These requirements are not so important in certain plastics. In such cases the question of price would be the controlling factor for the replacement of wood flour by ground cobs.

Due to war conditions consideration has been given to ground cobs as a replacements for granulated cork. The cob particles are much harder and less resilient than cork, and where resiliency is required the ground-cob particles are not an equal substitute. However, their resistance to abrasion and wear would indicate suitability of use in materials such as composition shoe soles, stair treads, and the like. It has been reported that ground-cob flour of about 50-mesh size is suitable as a replacement for cork in linoleum manufacture. Another use for cobs, although rather small, is as a replacement for beech or other wood shavings as a bacterial-film-supporting medium to provide maximum oxidation conditions in the manufacture of vinegar.

Cobs may be used as an absorbent in the manufacture of dynamite. Pithlike particles, such as those from sugar cane or cornstalks, make a good absorptive material for nitroglycerine in the manufacture of low-density permissible dynamites. An apparent density of from 0.15 to 0.10 is required for such material, and the material must be free from sand and metal particles which would ca[illegible] formation of a spark in compounding. The ordinary woody material of the cob is too dense to meet such specifications, but it is reported that by suitable extraction of the cob particles, the apparent density can be lowered to the specific limits indicated. —*The Chemurgic Digest.*

GAS SHORTAGE

Met in Brazil by Use of Producer Gas

THE use of "producer gas" for powering automobiles in Brazil, to meet a shortage of petroleum products more acute in that country than in the United States, was described recently by Dr. Tharcisio D. de Souza Santos, an engineer from the Institute of Technological Research of the University of Sao Paulo, Brazil.

"As a result of substitutes adopted to combat the shortage of petroleum products, Brazil has not suffered to any material extent," Dr. Santos says.

Wood and native coal have displaced a large fraction of the fuel-oil consumption in industries, he explains. Producer gas and pulverized charcoal are extensively used as substitutes for fuel oil in industrial furnaces. Fuel oil is severely rationed and quotas are granted only to some industries essential to the war effort where substitution is difficult. Much has been accomplished in Brazil in this field and further progress is being made.

"Automobiles were first to be sacrificed when the shortage developed. Gasoline has been under strict rationing throughout Brazil since May, 1942. After July 9 of that year, no private cars of any kind were allowed to run Bus lines have been cut to the minimum absolutely necessary. Taxicabs and trucks are entitled to ration coupons only for essential transportation. Even before Brazil entered the war, the government encouraged the use of producer gas or 'gasogenio' and dehydrated alcohol as native fuels to substitute for gasoline in engines. The latter is produced in substantial amounts from sugar cane.

"Had it not been for the large substitution of producer gas, the transportation situation would have been crippled badly," declares Dr. Santos.

"Today one sees in Brazil a large number of vehicles producer-gas powered," he says. "Since August, 1942, private cars can get a license only if they have a gas producer. In order to preclude their obtaining gasoline in the black market, the gas tank is removed from the car and frequent inspections are made."

Producer gas is obtained from the partial combustion of charcoal in a reducing atmosphere which takes place in a generator placed at the back of the car. Charcoal is the ideal fuel as it has a low ash content. The gases contain in suspension fine particles of charcoal dust as well as distillation products which have not been completely removed in the wood distilling. Both of these must be removed through filters before the gases go to the engine.

Also, as the gases are hot and give a low heat value per unit of volume, they must be cooled to increase it accord-

ingly. From the generator the gases are drawn through cooling chambers where the charcoal dust is deposited and then through a fine filter medium, generally a woolen cloth, where the fine dust is precipitated.

As the heat value of the gases is lower, the power output of the engine is about 50 percent of the power produced by gasoline. The consumption of charcoal is low — about 1½ pounds per mile.

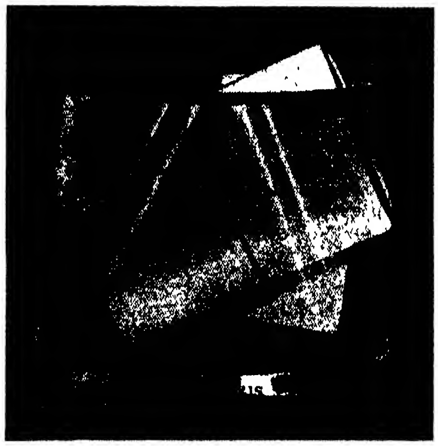
Trucks using producer gas are allowed to retain gasoline tanks and switch to their use if necessary.

The system of generator, cooling chamber, and filter is contained in a cylinder about 12 inches in diameter and four or five feet high. This is made of scrap sheet steel, about 300 pounds being required. "It makes a bulky load," says Dr. Santos, "and producer-gas powered cars are certainly not good looking, but they have been found a good solution for wartime to save gasoline for the essential requirements of the country."

PLASTIC ENVELOPE

Keeps Blueprints, Factory Orders, Office Forms Clean and Neat

MADE of cellulose acetate plastic and designed as a protective covering for work orders, blue prints, maps, charts, diagrams, and other factory and office



Keeps papers clean yet visible

forms, a new envelope keeps the contents clean, neat, and visible at all times.

Bound leatherette edges on all sides prevent the envelope from tearing or breaking; patented lock-stitch on binding will not unravel; envelope is flameproof, moisture-proof, oil-proof. Eyelets or straps can be provided where required.

TUBE INDENTIFICATION

Made Simple by Use of a Standard Business Machine

A NEW process for printing part numbers rapidly on appropriately colored calendar tape used in the identification of warplane tubing, thereby saving time and cost as well as speeding repairs on vital war fronts, has saved approximately 76 percent of the cost of a

former method of identification in one of the warplane plants of Curtiss-Wright Corporation.

An achievement of the labor measurement department of the organization's Airplane Division, the new process utilizes an ordinary office machine —the addressograph—to print the vital part numbers on each strip of colored calendar tape before it is pasted to a piece of tubing destined for the internal system of either a Curtiss Warhawk (P-40) fighter or a giant Curtiss Commando (C-46) military transport type.

Because of the wide variety of liquids and gases needed to operate the airplane of today, American plane manufacturers have standardized on a color coding which must permanently identify each length of tubing installed. As examples: A tube banded with red indicates that it is conveying gasoline, a yellow band means lubricating oil, a combination of red, yellow, and blue stripes indicates hydraulic oil used extensively to operate brakes, landing gears, wing flaps, and numerous other essential equipment.

The complex nature and limited space available in a modern plane have made the job of factory tubing assembly and the replacement of damaged tubing by field crews an extremely trying one. The identification of these tubes by part numbers is a constant source of trouble since many tubes carrying similar liquids and gases are almost identical in pre-formed shape.

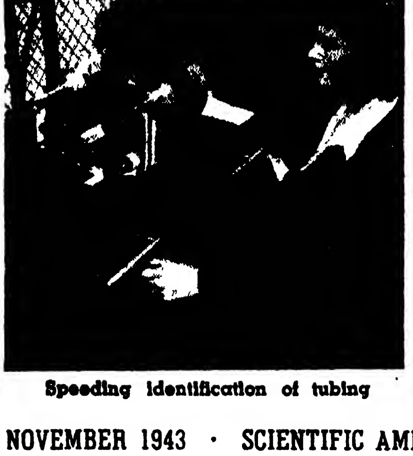
The new procedure combines the identifying part number with the appropriate colored tape and all tubes now being used at one of the Curtiss-Wright plants are permanently coded and numbered in the tube-forming department by this new method.

Previous identification methods included the use of rubber stamping and metal tagging for part numbers but both of these methods required the addition of colored cellulose tape.

To the Nashua Package Sealing Company goes the credit of developing a paper tape with an adhesive which is standing up well under rigorous tests and which is also lower in cost than the tape which it has replaced.

The printing of the tape is accomplished on a standard Addressograph and the only special equipment required is the simple device which automatically feeds and rewinds the tape.

The following comparison between the old and the new method gives fig-



Speeding identification of tubing

ures which include all labor and materials and which are based on actual cost of banding 25,000 pieces of tubing in production.

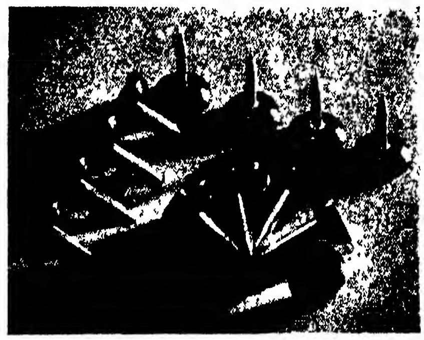
Total Cost — Old Method	$ 750 61
Total Cost — Addressograph Method	171.95
Total Dollar Saving per Run	$ 578.66

These money savings, while substantial, do not tell the whole story, since the identification of each tube cannot be valued intrinsically.

FIRING PINS

With Molded Plastic Heads, Metal Alloy Shanks

THEY LOOK like thumbtacks—in fact, might even be used for thumbtacks—and are being used to prod the Axis. They are firing pins—and something rather new in the way of firing pins. The head is molded of a medium impact Durez plastic by Globe Tool and Molded Products Company. The pin



Firing pins, not thumbtacks

itself is of a metal alloy and molded solidly in the Durez head. It is surprising when one thinks of the big jobs these little pins perform, yet a firing pin is just as vital to certain types of shells as the explosive, the container, the fuse.—*Durez Plastic News.*

CONCRETE PROTECTION

Afforded by Freeze-Resistant Resin from Pine Wood

HIGHWAYS in at least 15 states, and concrete runways on airplane landing fields, have been made resistant to severe winter conditions through the addition of about a tablespoon of Vinsol, a pine wood resin, to each sack of cement.

To eliminate surface scale caused by freezing, thawing, and applications of salt for ice removal, chemists of Hercules Powder Company have worked for five years in co-operation with various state highway departments, federal agencies, and the Portland Cement Association.

Fractional amounts, ranging from 2½ to 4½ parts in 10,000 (.025 to .045 percent) of the resin are added by cement manufacturers to the clinker during grinding. The resin is extracted from southern pine wood.

Test roads, on which strips of resin-

treated portland cement concrete were laid side by side with untreated concrete, have been constructed in Delaware, Illinois, Indiana, Kentucky, Maine, Massachusetts, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, South Carolina, Utah, and Wisconsin. The Queen Elizabeth Way in Canada, from Niagara Falls to Toronto, also has sections containing resin-treated cement.

These roads show that in states where the strip of untreated concrete has deteriorated due to winter conditions, the section of resin-treated cement concrete alongside it remains unaffected. Laboratory tests show that in all cases this resin-treated portland cement has superior resistance to freezing, thawing, and applications of salt.

Vinsol-treated cement has also been used extensively by the United States Corps of Engineers for numerous jobs, principally in the construction of military airports throughout New England, New York, Michigan, and Illinois, the company disclosed.

SECRET ADHESIVE

Combines Thermoplastic and Thermosetting Qualities

WHAT IS reported to be a radically new type of adhesive developed by the Du Pont Company, is being used to bond the thin sheets of wood that are molded to form the bodies of military helicopters, the planes with the rotary wings, it was announced recently.

"The most important of several unusual qualities of this new plywood glue is that it is both thermoplastic and thermosetting," says R. C. Peter, Du Pont Finishes Division chemist. "This means that when ply-covered forms are heated under pressure in ovens, the adhesive at first becomes fluid and permits the layers of thin wooden strips to move into intimate contact. After only 20 minutes the adhesive sets as a permanently tough, heat-resistant, insoluble material"

Plywood bonded with Adhesive No. 4624—its composition is still secret—is unaffected by the high temperatures that build up in the interior of airplane surfaces under a tropical sun. In fact, plywood of this type will withstand being boiled in water for three hours.

Adhesive No. 4624 is more costly at present than previous commonly-used plywood bonding agents. "Yet its relative costliness is compensated for by its properties," says Mr. Peter. It retains its flexibility at low temperatures when most adhesives become brittle. Moreover, its weight as a plywood bonding agent is almost one fourth less than other suitable materials, an important factor in plane construction. Its initial plastic quality in the bag-molding process, permitting perfect contact of the laminations, not only greatly reduces the number of rejects, but improves the aircraft safety factor.

Mr. Peter revealed that No. 4624 contains none of the substances previously common to adhesive manufacture. The product is available today only for military use.

Current Bulletin Briefs

Conducted by
K. M. CANAVAN

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

BLUEPRINTS FOR FASTER, BETTER PRODUCTION is a 16-page illustrated pamphlet which lists sizes and uses for various types of units made of abrasive cloth. Included are spiral-wound bands, points, cords, pencils, slotted disks, pads and cones, and so on. *Behr-Manning Corporation, Troy, New York.—Gratis.*

PENICILLIN is a pocket-size booklet containing abstracts of 81 papers on the subject published since 1929. *Winthrop Chemical Company, Inc., 170 Varick Street, New York 13, New York.—Gratis to interested scientists.*

HANDBOOK FOR THE WELDING AND CUTTING OPERATOR is a 20-page pocket size booklet which instructs users of the oxy-acetylene process in methods for prolonging the life of their equipment. Short, pertinent suggestions are illustrated with explanatory drawings. *The International Acetylene Association, 30 East 42nd Street, New York, New York. —Gratis.*

MUSIC AND MANPOWER is a 16-page pamphlet outlining the effectiveness of music in terms of mass production with minimum man-hours. *Operadio Manufacturing Company, St. Charles, Illinois.—Gratis.*

WHITING PRODUCTS FOR INDUSTRY is a 24-page illustrated book giving condensed facts on a line of cranes, railroad and aviation equipment, cupolas and foundry equipment, evaporators and filters, and so on. *Whiting Corporation, Harvey, Illinois.—Gratis.*

DUST AND FUME CONTROL EQUIPMENT is a 42-page plastic-bound, fully illustrated bulletin which describes typical installations of all kinds of equipment for dust and fume control, including spray booths, mechanical washers, industrial ovens, and sheet metal equipment and accessories. A series of tabulations presents pertinent and useful engineering data. *Schmieg Industries, Piquette at Brush, Detroit, Michigan.—Gratis.*

MANY PROBLEMS INVOLVED IN THREAD GRINDING ART is a four-page folder presenting an informal discussion on these problems and on the selection of grinding wheels for specific jobs. *Macklin Company, 42 Lawrence Boulevard, Jackson, Michigan.—Gratis.*

ELEMENTARY ELECTRICITY FOR RADIO STUDENTS, by W. E. Flood, M.A., is a 64-page pocket-size booklet written in England but published in the United States, which offers a sound background of basic facts which will aid students and others in understanding the principles of radio operation. Problems are offered to afford practice on the work described. *Longmans, Green and Company, Inc., 55 Fifth Avenue, New York, New York.—40 cents.*

IDENTIFICATION OF CONSTITUENTS OF ALUMINUM ALLOYS, Technical Paper No. 7, by F. Keller and G. W. Wilcox, describes the steps necessary for such identification. These steps include preparation, polishing, etching procedure, and so on. A number of photomicrographs illustrate the text. *Aluminum Company of America, Pittsburgh, Pennsylvania.—Gratis.*

PUNCHING & NOTCHING EQUIPMENT is an eight-page illustrated folder describing the design features of extremely flexible equipment for a number of industrial applications. *Wales-Strippit Corporation, 345 Payne Avenue, North Tonawanda, New York.—Gratis.*

EBERBACH MICRO HARDNESS TESTER is a 10-page illustrated pamphlet which describes a precision instrument for the purpose, as well as accessories, and gives directions for accomplishing this type of work. *Eberbach and Son Company, Ann Arbor, Michigan.—Gratis.*

SUCCESSFUL RADIO REPAIRING WITH AVAILABLE SUBSTITUTE PARTS is a pocket-size booklet designed for radio technicians who must cope with the changes which the war has forced upon their operations. *Supreme Publications, 328 South Jefferson Street, Chicago, Illinois.—25 cents.*

LINDBERG FURNACES is an eight-page illustrated bulletin describing units for heat treating the non-ferrous metals such as aluminum and magnesium. These units feature temperature uniformity and control accuracy. *Lindberg Engineering Company, 2450 West Hubbard Street, Chicago, Illinois.—Gratis.*

SAFETY TREADS is an eight-page illustrated pamphlet which describes various types of treads for use on ship ladders and decks, as floor plates, on thresholds, and so on. All are designed toward promoting safety in industry. *Wooster Products Inc., Wooster, Ohio.—Gratis.*

FLAT SPRAY NOZZLES is a six-page folder describing a new spray nozzle which has various uses ranging from cooling fruit in packing plants or cleaning trolley busses to washing logs in lumber mills or descaling sheets and plates in steel mills. The nozzle itself is a non-clogging device which projects a high velocity spray. *Chain Belt Company, 1600 West Bruce Street, Milwaukee, Wisconsin.—Gratis.*

HARD-FACING WITH COAST METALS is a 12-page illustrated pamphlet which presents a description of this effective maintenance method, together with a tabulation of hard-facing welding rods, typical applications, and specific examples. *Coast Metals, Inc., 1232 Camden Avenue, S.W., Canton, Ohio.—Gratis.*

Previews of the Industrial Horizon

(*Continued from page* 195)

electricity, Mr. Hibben points out that such developments will call for more adequate home and industrial wiring, a field in which little progress has been made in the past 30 years. Here, then, is food for thought for those directly interested in the electrical industry.

PRESSED METALS

SOME of the present industrial uses of the science of pressing metals into various shapes are dealt with in the article starting on page 208. From these will be gained a comprehensive view of the possibilities of replacing expensive and time-consuming forging and casting operations in many fields. A survey of such operations in any plant will undoubtedly reveal applications of pressing techniques that will speed up production, result in materials savings, make a better product, or produce a combination of some of these desirable ends.

COTTON

KING COTTON has ruled the South for generations, alternately reigning with arrogance from on high and crying for help from the depths. Now, it appears, something more than sporadic attempts to solve cotton's problems is going to be done. Rayon and other fibers are cutting deeply into cotton's tire-cord monopoly and are threatening other strongholds.

Science, however, is starting to alter the situation on a continuing basis. Designs for cotton goods are being developed in a variety of forms; chemical treatments are being worked out to change the feel, the appearance, and the quality of cotton fabrics; cotton is being made water-proof, rot-proof, fire-proof, and spot-proof; agricultural experts are developing plants which will produce better grades of the fiber in larger quantities. Things are being done that may go far to restore the King to his throne.

ONLY EYES CAN SEE

ONE of the crying needs of industry is for increased safety in plants, and in no one phase of safety is this need greater than in the protection of eyesight. Some plants, of course, according to surveys reported by the Better Vision Institute, are carrying on educational programs in respect to vision, but in many factories there is a wanton disregard of the importance of vision.

There is no satisfactory substitute for human eyesight (phototubes to the contrary, notwithstanding). Production speed is reduced, materials are wasted, health is impaired when vision is neglected. These factors will be just as important in the future as they are today and certainly merit intelligent and continuing attention. An industrial eyesight program should not stop with such elementary safety precautions as compulsory use of goggles but should include measures to prevent premature dimming of vision from causes from within as well as from outside the body.

COMBINED SCIENCES

"OPTI-ONICS" is a word coined by Bell and Howell to designate some of the as-yet secret work which they are doing and which involves a combination of the science of electronics and optics. Understanding of the basics can be had from television, where the electronics engineer provides the image on the face of a cathode-ray tube and the optical engineer devises means of enlarging the image to usable size.

Stressing war-imposed secrecy, the company says: "Some of the things we have learned in Opti-onics are almost startling in their implications and in the future developments made possible.

BETTER CONCRETE

OUTSTANDING point of the article on concrete ships (page 205), although perhaps somewhat subdued in the overall discussion of the subject, is the fact that new knowledge is being obtained about an old structural material.

No longer is concrete merely cement, sand, and aggregate mixed with water and used. Studies of the combination have revealed new materials, new mixing techniques, new methods of putting improved concrete into place. The concrete ships described are going to be more than means of water transportation; they represent accumulated research which will make itself felt in other engineering fields where concrete is used. Nor is this all: The newer materials, proved at sea, will undoubtedly suggest applications for concrete where none existed before.

BETTER WATCHES LATER

MASS production of chronometers through the exercise of Yankee ingenuity is turning out large numbers of fine instruments which meet the high standards and severe tests imposed by the Navy. From this mechanization of a former manual art will come finer time-pieces in post-war days.

NON-REFLECTING GLASS

DEVELOPMENT for military uses of glass with non-reflecting surfaces, by American Optical and RCA, can be applied, with desirable results, to post-war manufacture of windshields sans dangerous reflections, less conspicuous spectacle lenses, more easily read instruments, faster camera lenses, shop windows free from reflections, more efficient microscopes and other light-transmitting instruments, and so on.

New Products

COIL LIFTER

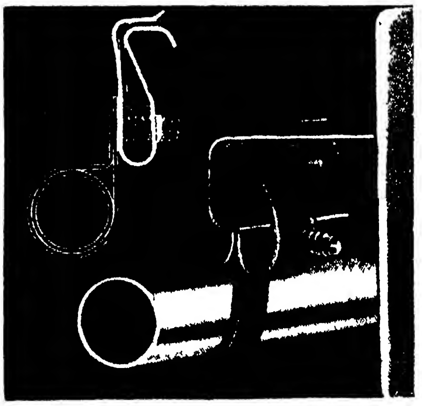
For safe handling of coils of strip a new lifter is readily adjustable for a wide range of coil sizes. It is particularly designed for handling coils in a

Adjustable for various coil sizes

horizontal position without first raising the coil, as no part of the lifter is underneath the coil. This lifter, made by the Never-Slip Safety Clamp Company, can be used on any crane or hoist and requires little head room.

SPEED NUT

With the present trend toward more widespread use of rolled metal sections, an entirely new speed nut has been developed for more rapid assembly of conduit, piping, and wire harnesses in aircraft. This nut is made of special



Rolled-section speed nut

aircraft spring steel with a zinc metal spray finish. It is designed to quickly snap around rolled sections or stringers and eliminates the need of drilling holes. As the screw in the speed nut, manufactured by Tinnerman Products Inc., is tightened, the two legs are forced inward to give a firm spring tension grip

MOLDING POWDER

Although available for war purposes only at the present time, a new form of Lucite has been developed for injection molding processes. It is claimed that the parts molded of this material, available in crystal clear or dyed form, will not soften appreciably or distort in temperatures up to 212 degrees, Fahrenheit.

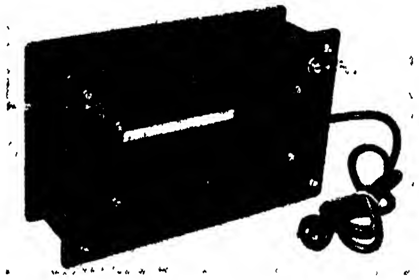
The material will also be available in granular form for compression molding.

CONCRETE IMPROVER

A liquid material designed to be added in small quantities to a concrete mix is claimed to act to disperse cement particles more universally and to improve the workability of the mix. Known as Santorized Trimix Liquid, this material reduces by 20 percent the amount of water required and is said to produce an increase in compressive strength in the resulting concrete.

DEMAGNETIZER

Tools and other metal parts may be either demagnetized or magnetized in the new unit illustrated in these columns, made by the Alofs Manufacturing Company. Drills and tools which would otherwise become dull through magnetization are simply passed through the core of the demagnetizer.



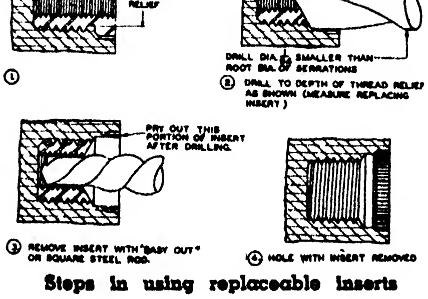
For magnetizing or demagnetizing

Metal parts to be plated may be demagnetized in the same manner, thus preventing the adherence of metal particles which may be detrimental to the finish.

The same unit may be employed to magnetize tools such as screw drivers and wrenches, for use in difficult assembly jobs.

REPLACEABLE INSERTS

A new application of the Rosán Locking System for threaded inserts and studs is designed for use in plastics or other molded materials which require fastening points. Like the standard Rosán threaded inserts and studs, it is locked in, but can be removed without injury to the material and replaced by



Steps in using replaceable inserts

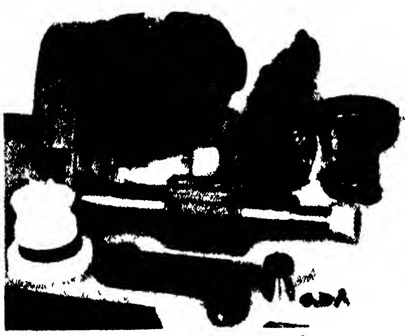
a standard locked-in threaded insert.

On the standard insert or stud, there is a serrated collar. The Rosán locking ring, which is serrated both inside and out, engages its inner teeth with the serrations on the collar while its outer teeth or splines broach their way into the parent material at the sides of the counterbore. The pressure of the surrounding material causes the ring to close in upon the collar enough to eliminate all tolerance and make a solid installation which is permanent.

To remove the one-piece molded-in insert for replacement with the Rosán standard unit, the serrated locking head at the top of the insert is drilled until the drill passes into the thread relief. (See drawings.) This leaves the outer portion of the head in the form of a serrated ring. An "easy out" tool inserted in the drill hole backs out the threaded portion of the insert. The remainder of the ring may be lifted out by hand. The procedure for removing the one-piece molded-in stud is the same except a hollow mill is used for drilling out the serrated locking flange of the stud. The threads and serrations are left molded in the material so that standard units may be installed without further operations

TOOL POST GRINDER

FOR INTERNAL, external, face, and taper grinding on lathe, shaper, planer, miller, or bench, a new small heavy-duty grinder grinds holes 8½ inches

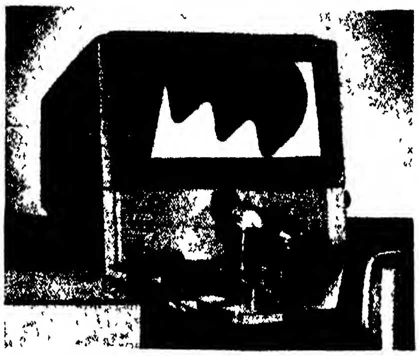


Heavy-duty grinder parts

deep and produces commercially perfect finishes. The quill adjustment of the unit provides the equivalent of two different length quills without the necessity for an extra quill because the motor may be shifted two inches on a slide bracket. The grinding quill is likewise adjustable. This feature also saves considerable set-up time on jobs that require different length quills. This tool-post grinder is made by Lempco Products, Inc

CONTOUR COMPARATOR

THE F. S. Optical Comparator is an instrument for quickly, simply, and accurately measuring and comparing intricate shapes for purposes of inspection It is particularly adapted for inspection of parts from mass production, which are not easily checked with customary gages. The instrument employs optical projection of the contour of the part to be measured or compared.



Parts comparison

The aspheric condenser system of the contour comparator—which operates in conjunction with a projection lens of special design—produces a sharp, magnified, undistorted image of the contour of the part being examined—free from disturbing color fringes, on a ground-glass screen, 9 by 15 inches. On the same screen is placed a sketch of the "standard" which has been drawn in the same scale of magnification on a transparent sheet A slight adjustment of the centering device will align this drawing with the contour of the projected object and permit a detailed comparative examination.

RESISTANT PAINT

DEVELOPED to protect the surfaces of metal, wood, and concrete against the action of acids, alkalies, gasoline, and so on, a new paint has a resin base and is applied by brushing, spraying, or dipping.

While this new paint, known as Ucilon. air dries to permit application of succeeding coats, it requires forced drying at a temperature of about 250 degrees, Fahrenheit, to develop maximum adherence and permanence

PHOTOELECTRIC SMOKE METER

SMOKE IN engine exhausts and flues can be readily detected and measured percentage-wise with a portable photoelectric meter recently developed by the Photovolt Corporation. This new equipment consists of an 18 inch-tube and the meter itself with the necessary controls.

In operation, clean air is first drawn

into the tube by means of a built-in fan, and the circuit is adjusted so that the meter reads 100 percent. Then the suspected air from the engine exhaust or boiler flue is drawn into the tube and another reading taken. The difference in the two readings indicates smoke density. Operation of this unit may be from a 50 or 60 cycle 110 volt A.C. line or from a six-volt storage battery.

BENDER

ACCURACY to a tolerance of .001 of an inch in all duplicating work is guaranteed in a new heavy-duty bending device recently announced by O'Neil-Irwin Manufacturing Company, makers of Di-Acro die-less duplicating equipment. This new model bender, Number Three, incorporates all the features of


Duplicated bending accuracy guaranteed to a tolerance of .001 inch

the smaller models which have been used successfully for the past several years. It has, however, a considerably greater radius-forming capacity, handling up to one-half inch round cold rolled steel bar, formed cold to a one inch radius or larger For more ductible materials the capacity is proportionately greater

WEAR INDICATION

THE COLORING processes for metals known as Black Magic and reported previously in these columns, is finding new application on plug, ring, and other types of gages as a means of indicating surface wear Since the coloring penetrates to a depth of .0001 inch, it does not change the dimensions of the gage, yet it shows up the bare metal in sharp contrast when the gage wears beyond this amount. Scratches or nicks also show up vividly. The color is applied to gages by boiling in a special salt solution, followed by rinsing in cold water. The treatment is claimed to retard corrosion and stain of parts to which it is applied

ELECTRO-ANALYSIS

THE NECESSITY for chemical analysis of an unknown alloy steel is eliminated by a new thermal-electric unit which checks the unknown material against known samples for identification purposes. The basis of this test equipment, developed by the Dravo Corporation, is the phenomenon of thermo-electricity, and depends upon the fact that a minute voltage is set up when two dissimilar conductors are in contact and have temperature differentials between the other conductor junctions.

In the Identometer test equipment, contact is set up by connecting the known and unknown steels to clamping terminals. A potentiometer reading may be taken. Lack of current flow indicates that the steels are of the same analysis while an indication of current shows that they are dissimilar.

The test can be applied also to large quantities of unknown materials by means of extension conductors reaching from the instrument housing. The unit is designed for operation on a 110 volt, 60 cycle A.C. power source

CARBOLOY SCRAPERS

THE WORN-OUT file, once the stand-by of scraping departments in tool rooms of machine shops, seems to be becoming a war casualty. With the advent of the war and the stress of getting production out fast, commercial scrapers tipped with cemented carbide are taking its place for finishing both iron and steel castings.

Prime reason for the development of this new tool was the need for accelerating production of machine tools One of the bottle-necks in machine tool production was the necessity for carefully hand-scraping the ways and slides to high degree of finish and accuracy Steel scrapers — mostly converted files — proved too slow. A few scrapes and they had to be sharpened again. The introduction of flame-hardening aggravated the problem since the hardened surface further decreased the life per grind of the steel scraper. Some steel surfaces with weld spots could not be scraped at all

Independent tests carried out at the Batelle Institute at the instigation of one of the leading machine tool builders revealed that by tipping scrapers with Carboloy cemented carbide, the formerly unscrapeable surfaces could be scraped with a longer life per grind than the previously most easily scraped materials.

The new scrapers are being made with special steel handles, strong enough to withstand pressure without deflecting or bending.


Replacing the worn-out file

A New Industrial Frontier

By FRANKLIN P HUDDLE

(Continued from page 213)

through spontaneous acknowledgements made by the engineers they assist."

The anomaly presented by the most productive country in the world of manufactured goods, in the position of having ignored a significant and efficient aid to production, inspired investigation. The resulting report clearly indicated the need for intensive work by this country to expand its available personnel of applied mathematicians.

In response to this need Brown University, in the summer of 1941, initiated what has become, for this country, a unique program of "Advanced Instruction and Research in Mechanics and Allied Branches." The work was approved as a part of the Engineering, Science, and Management Defense Training program of the United States Office of Education.

The program at Brown began with courses in elasticity, fluid dynamics, and partial differential equations. Even before Pearl Harbor the demand for mathematical technicians had sharpened so much that the emphasis of the school shifted from a long-range to a short-range point of view. Advanced students attacked problems relating specifically to war production and students completing course work were encouraged to enter immediately into various centers of war activity. Although the war has become the vital and immediate concern, at its conclusion the project must be returned to its original, long-range aim of developing applied mathematicians to serve this country's industry.

The objective of the course, defined by an Evaluating Committee[4] in a report, is "To increase the application of the analytical techniques of mathematics to practical problems, and in particular to problems of engineering and industry."

The course is designed first to adopt competent mathematicians to the war program, second to prepare able men for teaching mathematics to prospective scientists and engineers, and third to initiate competent students into research in these fields. This program answers the particular recommendation of the Evaluating Committee "that a long-range but solid and sure attack can be made on the problem through an essentially educational effort, aimed at recruiting very high grade men and giving them thorough and deep training for careers as teachers of applied mathematics."

For advanced students actual research problems are submitted by aeronautical and marine production authorities. By this means the student body is taught the technique of answering such problems of production, and at the same time the problems are solved. In addition, the student body is expected, after receiving the training, to apply it as soon as possible. A partial list of the students indicates that they are meeting this obligation creditably.

Seven students who have taken courses hold research posts at the David Taylor Model Basin; three have gone to the National Advisory Committee on Aeronautics at Langley Field; four are at the National Defense Research Committee Radiation Laboratory at M.I.T.; one is doing N.D.R.C. work at the Cruft Electrical Engineering Laboratories at Harvard, and another at Rockefeller Center; two more are attached to the Signal Corps Laboratories at Fort Monmouth, N. J.; two men are doing research in meteorology for the Army; four men are giving instruction in the Navy; two are doing sonics research and one ballistics research for the Navy; one is at the National Bureau of Standards; one is teaching mathematics at the Air Corps School at Chanute Field; three are doing work for the government in ballistics and ordnance; another nine hold industrial posts, three with Pratt and Whitney, two with Curtiss Wright, and one each with the U. S. Rubber Company, the American Can Company, and the Chrysler Corporation. This is only a partial list but the number is more significant when one remembers that only about 150 applied mathematicians were employed in American Industry in 1939.

Many of the faculty members at Brown were doing research or teaching in German technical schools when Hitler rose to power. For different reasons they found the Nazi regime unacceptable. Several went to Turkey because the Turkish government was making an effort to stock its technical schools with German political refugee scholars.

In a sense the cosmopolitan quality of the organization at Brown is a fine thing and illustrative of a development in contemporary history that most people would like to see pursued. However, in another aspect the scant contributions made by our own citizens indicate a weakness that should be overcome. As a matter of pride we should increase our proficiency in this field so that American contributions will rank with European in the application of mathematical science to industry. And finally, if we are to do our part in the production of world-wide scientific knowledge we would be foolish to neglect a field in which relatively slight efforts are so disproportionately rewarded.

[4] The Evaluating Committee appointed to weigh the merits and recommend direction of the Brown School of Applied Mathematics, consisted of Marston Morse of the Institute for Advanced Study and at that time President of the American Mathematical Society; Mervin J Kelly, Research Director, Bell Laboratories; George B Pegram physicist and Dean of Columbia Graduate School Theodore von Karman, Director of Aeronautical Laboratories, California Institute of Technology and Warren Weaver, Director for Natural Science Rockefeller Foundation.

Telescoptics

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

IN LETTERS, and orally for years and years, readers of this department have been saying, sometimes strenuously, that they doubted greatly that Ellison's claim to be the originator of the auto-collimation test for objective lenses could be justified. His claim appears in Chapter XI of his part of "Amateur Telescope Making," where he says he "believes he was the first to devise, and he certainly was the first to publish," a simple means for testing objective lenses—the familiar auto-collimation test.

Your scribe did not, however; pursue the question to a finish before Ellison died. A letter from a reader who questioned the claim was once sent to him and in his reply, now lost or misplaced, he said he now claimed only independent discovery. He was asked whether the text of "A.T.M." should not therefore be altered (he was always most jealous of alterations to that text) but did not allude to this question when he next wrote; hence nothing was done at the time.

In 1928, when it was first decided to include his chapters on the objective lens in "A.T.M." (second edition), and he was asked if this was satisfactory to him, he sent us a full typescript of these chapters, with a few small alterations. But he did not, while so doing, alter his claim to the discovery and original publication of the auto-collimation test.

In December, 1936, he died.

Some time later, while browsing through old files of *English Mechanics,* a communication from Ellison was found (April 4, 1924, page 166) in which he had even then, in Britain, altered his claim to "independent discovery." Had he changed his mind in the meantime?

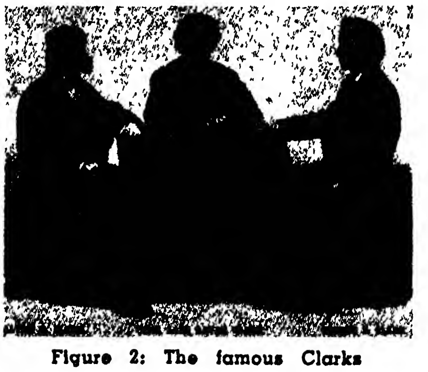


Figure 2: The famous Clarks

In September, 1937, after Ellison had died, W. H. Newman, Ditchling, Sussex, England, provided the governing data. While browsing through old files of *Engineering* (London) for 1888 he had come across an abstract of an article about the celebrated Clarks of Cambridge, Massachusetts, in which the auto-collimation test was described, and that abstract was from an article in Scientific American! No date was given, and for some reason Newman's letter found its way into your scribe's archives without the article being hunted up in Scientific American back files.

Recently, the Newman letter was encountered, a search was made and the article found in Scientific American

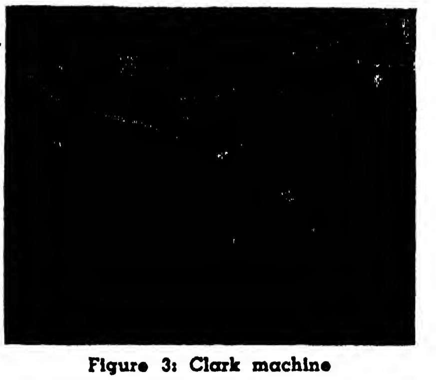
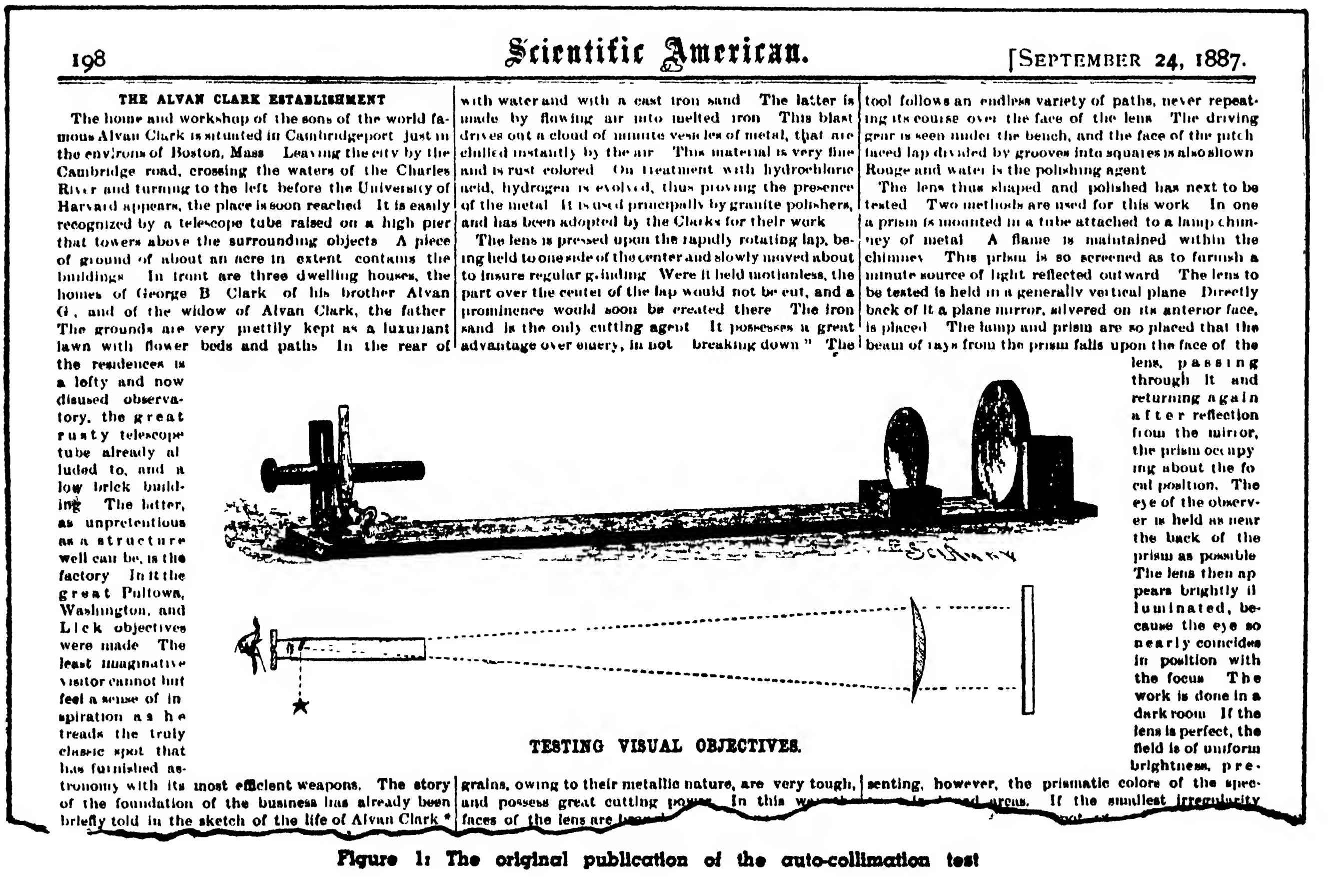


Figure 3: Clark machine

Sept. 24, 1887. (Why, you ask, didn't your scribe remember it? Because, while he was then on the way, he was not yet born.) A part of that article is reproduced in Figure 1. Matter pertaining to tests begins in column 3 of that figure, which should be read before proceeding.



198 Scientific American. [SEPTEMBER 24, 1887.

THE ALVAN CLARK ESTABLISHMENT

The home and workshop of the sons of the world famous Alvan Clark is situated in Cambridgeport just in the environs of Boston, Mass Leaving the city by the Cambridge road, crossing the waters of the Charles River and turning to the left before the University of Harvard appears, the place is soon reached It is easily recognized by a telescope tube raised on a high pier that towers above the surrounding objects A piece of ground of about an acre in extent contains the buildings In front are three dwelling houses, the homes of George B Clark of his brother Alvan G, and of the widow of Alvan Clark, the father The grounds are very prettily kept as a luxuriant lawn with flower beds and paths In the rear of the residences is a lofty and now disused observatory, the great rusty telescope tube already alluded to, and a low brick building The latter, as unpretentious as a structure well can be, is the factory In it the great Pultowa, Washington, and Lick objectives were made The least imaginative visitor cannot but feel a sense of inspiration as he treads the truly classic spot that has furnished astronomy with its most efficient weapons. The story of the foundation of the business has already been briefly told in the sketch of the life of Alvan Clark *

with water and with a cast iron sand The latter is made by flowing air into melted iron This blast drives out a cloud of minute vesicles of metal, that are chilled instantly by the air This material is very fine and is rust colored On treatment with hydrochloric acid, hydrogen is evolved, thus proving the presence of the metal It is used principally by granite polishers, and has been adopted by the Clarks for their work

The lens is pressed upon the rapidly rotating lap, being held to one side of the center and slowly moved about to insure regular grinding Were it held motionless, the part over the center of the lap would not be cut, and a prominence would soon be created there The iron sand is the only cutting agent It possesses a great advantage over emery, in not breaking down " The grains, owing to their metallic nature, are very tough, and possess great cutting power. In this ... faces of the lens are ...

tool follows an endless variety of paths, never repeating its course over the face of the lens The driving gear is seen under the bench, and the face of the pitch faced lap divided by grooves into squares is also shown Rouge and water is the polishing agent

The lens thus shaped and polished has next to be tested Two methods are used for this work In one a prism is mounted in a tube attached to a lamp chimney of metal A flame is maintained within the chimney This prism is so screened as to furnish a minute source of light reflected outward The lens to be tested is held in a generally vertical plane Directly back of it a plane mirror, silvered on its anterior face, is placed The lamp and prism are so placed that the beam of rays from the prism falls upon the face of the lens, passing through it and returning again after reflection from the mirror, the prism occupying about the focal position. The eye of the observer is held as near the back of the prism as possible The lens then appears brightly illuminated, because the eye so nearly coincides in position with the focus The work is done in a dark room If the lens is perfect, the field is of uniform brightness, presenting, however, the prismatic colors of the spec- ... areas. If the smallest irregularity ...

TESTING VISUAL OBJECTIVES.

Figure 1: The original publication of the auto-collimation test

The following is the continuation of the text reproduced in Figure 1: "If the smallest irregularity exists, it appears as a spot or ring or other area on the glass.

"In the other method, which is shown in the illustration, the source of light is a minute bead or convex surface of glass, carried in the center of a sighting tube, about six inches long. The light from a lamp is received on this and dispersed. All is arranged otherwise as before. The pencil of light from this source, representing almost a mathematical point, is received and transmitted by the lens as before, is reflected from the mirror, and again transmitted.

"In these methods the rays of light pass twice through the lens, so that a doubling of the effect due to a misshape is obtained. The Clark process, therefore, is of twice the delicacy of the older methods."

So this is where you end when you start tracing the auto-collimation test—at the Clarks, who obviously made it public as long ago as 1887, through Scientific American.

It seems probable that Ellison himself never was certain about the matter. He lived far from any large library where he could have run the question down, and probably had to depend largely on oral advices and loose suppositions put forth by others.

The same article, written obviously by some visiting member of Scientific American's staff but anonymously, as was the editorial custom of the time, indicates that the 36" objective lens for Lick has just been finished by the Clarks and it contains a wood-cut (Figure 2) which is also reproduced because, while the name of the famous Clarks is everywhere mentioned in optical literature, the men themselves have become vague and shadowy—their pictures seldom seen. Alvan Clark, the father (central figure), had died only a month before, in August, 1887. Alvan G. and George B. Clark were the sons.

To an amateur telescope maker, an outline of the elder Alvan's career, from Scientific American, September 3, 1887, should be much to the point. Son of a farmer, he was artistic and for nine years worked as an engraver for calico printers, and then as a portrait painter for 11 more years. At this time, Alvan G. Clark, his son, was studying engineering at Andover and became absorbed in telescopes. The father began studying astronomy and mechanics, in order to instruct the son. Together they made a reflecting telescope. Encouraged by a Harvard professor, they next tried objective lenses and made out so well that they devoted themselves thereafter to making telescopes. Their reputation grew, reached England, and Dawes—the Dawes of "Dawes limit"—ordered a telescope in 1853. It did such fine work that many foreign orders for similar 5¼" objectives were soon received. By 1860 the Clarks had tackled an 18", then the largest objective in the world.

Larger and larger objectives were made in later years as the firm became more and more famous—leading up to the Lick and Yerkes lenses.

The story of the Clarks is told in much greater detail in G. Edward Pendray's "Men, Mirrors, and Stars." George B. Clark died in 1891, and the other son, Alvan G. Clark, in 1897. The Clark tradition then passed on to the Lundins.

Figure 3 is from a wood cut in the Scientific American article referred to above, where it was published with the following caption: "Machine used in polishing the Lick objective."

This mention of Lick makes your scribe's face blush to a deep long-winter-underwear red, for in the September number he stated that the donor Yerkes was buried in a crypt under the pedestal of the 40" refractor at Yerkes. It turns out that it was Lick who was thus buried, and at Lick Observatory beneath the 36" refractor There, darn it, goes a good story.

❁ ❁ ❁

Tyros are urged in "A.T.M." to make their first mirror about $f/8$, this being a sort of compromise between a number of partly conflicting considerations, but when making a second mirror it is not inadvisable to depart from this, either as a venture or for a specific purpose. For planetary work many prefer something like $f/10$ or $f/12$, which gives a larger image. E. White, Box 1, Ymir, B.C., Canada, has just made an 8½" $f/12$ (Figure 4) and says that "its performance is very good, both optically and physically. I designed it," he continues, "for observing lunar and planetary detail but it performs admirably on stars as well.

Figure 4: White of "Wymer"

Figure 5: White's motor drive

"The equatorial mounting (Figure 5) is motor driven by a train of gears made as per the instructions on hobbing ('A.T.M.A.' page 365) with a tap"

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with the names of available books, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for. Books listed in these columns may be ordered from our Book Department. Add 25 cents per book for mailing outside U. S.

TO MAKE CERTAIN that books ordered by or for men in the armed forces will be delivered, insurance fees should be sent with orders, as follows: To $5 in value, 5¢ additional; from $5 to $25, 10¢; from $25 to $50, 15¢.

FLYING FORTRESS

By Thomas Collison

THE WHOLE thrilling story of the development of the Flying Fortress from earlier types of planes, the planning and construction work, the training of the crew, to the work of the bomber, all supplemented by an outstanding collection of action pictures which might be said virtually to tell the whole story themselves. The concluding chapter deals with the amazing changes which the airplane will make in our post-war world. (168 pages, 7 by 9¾ inches.)—$2.60 postpaid.—*A.P.P.*

A MANUAL OF MECHANICAL MOVEMENTS

By W. M. Clark

FUNDAMENTALS on which all machines are built are here presented in a compilation of over 400 illustrated mechanical movements. Supplementing the drawings and descriptions are 160 photographs of models that demonstrate various mechanical principles. (456 pages, 5½ by 8½ inches.)—$2.10 postpaid.—*J.P.C.*

HANDBOOK OF ELEMENTARY PHYSICS

By Robert Bruce Lindsay

NOT a textbook but a physics student's companion containing: A 135-page dictionary of physical terms; tabular history of physics; detailed bibliography of suggested reading; collection of useful formulas; tables of physical constants; supplementary notes on experiments. This book will not stand alone but was written to supplement other books of physics. (382 pages, 5½ by 8 inches, sparsely illustrated) — $2 35 postpaid.—*A.G.I.*

EXPERIMENTS IN ELECTRONICS AND COMMUNICATION ENGINEERING

By E. H. Schulz and L. T. Anderson

BASIC circuit theory, electronics, communication networks, and radio and ultra-high-frequency techniques summarize the contents of this up-to-date volume for the student and engineer. A review of laboratory technique and equipment is first presented, the remainder of the text being largely in the form of explanatory experiments. (381 pages, 6½ by 9½ inches, a number of drawings.)—$3.10 postpaid.—*A.P.P*

THE GOD OF THE MACHINE

By Isabel Paterson

INDIVIDUALISM defended — vigorously, fervently. In an absolute sense this author is an extreme reactionary but, relative to recent trends, this will please many a reader. She discourses vehemently about social and economic forces of our era, refuting Marxism, and favoring private enterprise and private property in an extreme form—with the government governing to the least possible extent She describes in engineering terms how human energy best flows into production Not light reading but penetrating. (292 pages, 5½ by 8 inches, unillustrated.)—$2.85 postpaid.—*A.G.I.*

DISEASES AND PESTS OF ORNAMENTAL PLANTS

By Dodge and Rickett

FIRST comprehensive treatment of the diseases and pests of ornamental plants presented in one volume. It lists alphabetically 600 species of garden and greenhouse plants, names their diseases, and gives the proper control. It also discusses plant diseases, bacteria and fungi attackers, and insect and other animal pests not including dogs; finally discussing principles of control methods One of the authors is connected with the New York Botanical Garden. (638 pages, 6 by 9 inches, illustrated.)—$6 60 postpaid.—*J.P.C.*

STUDIES IN ARC WELDING

Design, Manufacture, and Construction

INTENSIVE application of the welding process, particularly during the past few years, has resulted in a great number of findings of outstanding importance to the whole art. Here is presented the cream of knowledge thus gained by 113 executives, engineers, designers, and production, construction,

and maintenance men. The papers presented are offered under headings of automotive, aircraft, railroad, watercraft, structural, furniture and fixtures, commercial welding, containers, and machinery. (1295 pages, 5½ by 9 inches, a large number of photographs, drawings, and tabulations.)—$1.50 postpaid. —*A.P.P.*

SCIENCE, PHILOSOPHY AND RELIGION

PAPERS discussed at a notable conference on Science, Philosophy and Religion. On such topics as Determinism and Responsibility; Moral Basis of Democracy; Nature of Value; Meaning of Human Dignity from a Theological Perspective. (438 pages, 5½ by 8 inches, unillustrated.)—$3.10 postpaid. —*A.G.I.*

DIESEL ENGINEERING HANDBOOK

Originally Edited by L. H. Morrison

PUBLISHED to meet the many demands from Diesel engine operators and owners, the present text has been brought completely up to date to 1943, yet contains the original fundamental material so essential to a thorough understanding of this modern power source. (926 pages, 6¼ by 9 inches, a large number of drawings and photographs.)—$7.10 postpaid.—*A.P.P*

NOXIOUS GASES

By Yandell Henderson and Howard W. Haggard

REVISED edition of a widely recognized technical book written especially for industrial chemists, engineers, and others, by scientists at Yale. Only those gases which occur in industry are dealth with, and these in a practical manner. (294 pages, 6 by 9 inches, 12 illustrations.)—$3.60 postpaid.—*J P.C.*

MANUAL OF LABORATORY GLASS-BLOWING

By R. H. Wright

PRACTICAL book containing outlines of the fundamental operations of glassblowing, elementary and more advanced. (90 pages, 5¼ by 8½ inches, 23 illustrations.)—$2.60 postpaid - *A.G.I.*

FUNDAMENTALS OF ELECTRICITY

By Johnson and Newkirk

A LARGE, well illustrated, and well arranged text, prepared for use in preinduction courses, this book follows with absolute conformity the army specification for skilled training. This is truly a basic book, perfectly understandable to the average student. (212 pages, 8½ by 11½ inches, 207 drawings and a number of photographs.) — $2.10 postpaid — *A.P.P.*

MINERALS IN WORLD AFFAIRS

By T. S. Lovering

BEHIND the events of history and of current affairs are major forces, some of them out of sight below the

The Editors Recommend

Best Sellers in Science

PLASTICS — *By J. H. Dubois.* Meaty information on the whole general subject of plastics, presented in narrative form for easy reading. Tabulations of properties of plastics, plus basic design information, for laymen and technicians alike. $3.10

EXPERIMENTAL ELECTRONICS — *By Ralph H. Muller, R. L. Garman, and M. E. Droz.* A solid book of eminently practical information on the characteristics and non-communication applications of electron tubes. The text describes experiments and presents results. For students, radio engineers, communications experts, and the serious general reader. $4.75

HOW TO READ ELECTRICAL BLUEPRINTS — *By Gilbert M. Heine and Carl H. Dunlap.* A chapter on how blueprints are made, plus nine other sections, each of which is devoted to a specialized part of the electrical field, from bell and signal wiring through motor control diagrams to power station blueprints. $3.10

GET TOUGH! — *By Capt. W. E. Fairbairn.* How-to-win-in-hand-to-hand-fighting directions, by a man who really knows rough-and-tumble methods that are *not* "clean" fighting but *are* designed to win. $1.10

FUNDAMENTALS OF PERSPECTIVE — *By Theodore DePostels.* Colored drawings are used to show the sequence in which lines are to be drawn in order to obtain correct perspective. This material is presented in binder form with 20 illustrative sheets. $2.60

LEARNING TO NAVIGATE — *By Weems and Eberle.* For those totally inexperienced or only casually familiar with the fundamentals of navigation, this text will provide a practical handbook leading to an understanding of navigation at sea or in the air. A number of illustrations and tabulations. $2.10

FUNDAMENTALS OF RADIO — *By Jordan, Osterbrock, Pumphery, and Smeby.* With this one volume alone, and with some diligence of application, it is possible to obtain a thorough grounding in radio principles. In thoroughness of treatment, with due respect for the needs of the reader, this book is outstanding. $5.10

POPULAR MATHEMATICS — *By Denning Miller.* Anodyne for those who have mathematical indigestion. Ground treated is arithmetic, geometry, algebra, analytical geometry, trigonometry, conic sections, solid geometry spherical trigonometry, calculus. The coverage is not complete; it is rather, a collateral book—and good friend. $3.85

ELEMENTS OF ORDNANCE — A textbook prepared for cadets of the United States Military Academy. Covers manufacture, the chemistry of explosives, types of weapons, mathematics of ballistics, etc. $6.60

AIRCRAFT INSTRUMENTS — *By George Ellis Irvin.* All types of instruments for aircraft are described for students, pilots, inspectors. Fundamentals, instructions. $5.10

MARINE DIESEL HANDBOOK — *By Louis R. Ford, M.A.* A compendium of data on design, construction, and operation of the marine Diesel engine with chapters covering applications, principles, types, fuel injection systems, lubrication, supercharging, and so on. $7.25

MACHINERY'S HANDBOOK—*Eleventh Edition.* "Bible of the mechanical industry," enlarged to 1815 pages of latest standards, data, and information required daily in the shop and drafting room. $6.10

PROCEDURES IN EXPERIMENTAL PHYSICS — *By John Strong, Ph.D.* A wealth of useful data of a practical kind for the constructor, experimenter, and skilled craftsman. $6.80

STEEL SQUARE POCKET BOOK — *By Dwight L. Stoddard.* Practical methods of using the carpenter's steel square for layout work of all kinds. Time-tried methods used by two generations of carpenters and found both rapid and accurate. $1.00

REFINING PRECIOUS METAL WASTES — *By C. M. Hoke.* A practical book, based on experience, dealing with processing, identification, and repurification of such metals as gold, platinum, silver, alloys, iridium, and rhodium. $5.10

WORKING WITH THE MICROSCOPE — *By Julian D. Corrington.* For the serious beginner. Explicit, practical. $3.60

TOOL MAKING — *By C. B. Cole.* Instructions for making and using all kinds, from personal tools to arbor presses, lathes, planers, etc., in different metals. $3.60

THE ELECTRON MICROSCOPE — *By Burton and Kohl.* A well-written account of this newest tool of science, with all technicalities explained for complete understanding by average persons. $3.95

ENCYCLOPEDIA OF KNOTS AND FANCY ROPE WORK — *By Graumont and Hensel.* More knots are described in this remarkable book than in any book on seamanship ever published or dreamed of. 3257 knots are illustrated in half-tone reproduction and are described in the text. $5.10

A MATHEMATICS REFRESHER — *By A. Hooper.* Prepared mainly to refresh aviation trainees whose high school mathematics is rusty. Scope — arithmetic through calculus. $2.60

PLASTICS, PROBLEMS AND PROCESSES — *By Mansperger and Pepper.* The whole story of plastics, including a resume of manufacturing processes and a number of thorough-going chapters devoted to plastic uses. $3.10

AUTOMATIC ARMS — *By Melvin M. Johnson and Charles T. Haven.* Comprehensively covers machine guns, machine rifles, sub-machine guns, pocket pistols, shotguns, sporting, military rifles in automatic classification. $5.10

MIRACLES OF MILITARY MEDICINE — *By Albert Q. Maisel.* The drugs, devices, and techniques used in the services. $2.85

HANDBOOK OF CHEMISTRY AND PHYSICS — A classic reference book recently revised and brought up-to-date to keep pace with recent research. Includes material on all branches of chemistry, physics, and allied sciences. Used in laboratories and by engineers throughout the country. Flexible binding, 2503 pages. $4.10 Foreign $4.50, postpaid

ATOMIC ARTILLERY — *By John Kellock Robertson.* Electrons, protons, positrons, photons, neutrons, and cosmic rays, all described for the layman in plain language. Also transmutation of the elements and the manufacture of artificial radio-activity. $2.35

The above prices are postpaid in the United States. Add, on foreign orders, 25¢ for postage on each book, except as noted.

For Sale by: November, 1943

SCIENTIFIC AMERICAN, 24 West 40th Street, New York 18, N. Y.

I enclose $.... for which please forward at once the following books:

....

....

Name ....

Address ....

Write us for information on books on any subject. We can supply any book in print.

... surface. One of these major forces is minerals, found in only an insignificant fraction of one percent of the earth's surface. It is this special aspect of mineral economics which the author, a well-known economic geologist, takes up. He deals with mineral economics, geology, metal trade which shapes world events and determines rational power; also with geography and control of important minerals and their trade movements; and with the outlook for the future. A penetrative book of data and its interpretation, for industrial bankers, capitalists (if any survive), and others who seek a broad understanding of economic basics about minerals. (394 pages, 5¾ by 9 inches, 36 illustrations.)—$5.45 postpaid.—*A.G.I.*

MODELS IN SEMI-TECHNICAL EXPOSITION

By Lawrence and Weisinger

ESSAYS selected from current literature are here presented in an anthology which has been built up to serve as a guide in the handling of semi-technical material for either oral or written discussion. Three of the articles are from Scientific American. (304 pages, 5½ by 7½ inches, unillustrated.)—$1.60 postpaid.—*J.P.C.*

PHOTOGRAPHY, ITS PRINCIPLES AND PRACTICE

By C. B. Neblette, F.R.P.S.

FOURTH edition of a standard reference manual widely accepted by amateurs and professionals alike. This new edition includes new methods and processes, new theory, the latest in practical information. (865 pages, 6½ by 9½ inches, a number of drawings, charts, and photographs.—$7.60 postpaid.—*A.P.P.*

NAVAL ARCHITECTURE AS ART AND SCIENCE

By C. O. Liljegren

CHALLENGE to traditional thinking in the science of ship design. A provocative book, since it isn't wholly orthodox. Part I is for beginners, Part II for more advanced students, and Part III breaks new ground on striking proposals for design elements. (212 pages, 6 by 9 inches, 53 illustrations.) —$4.10 postpaid.—*A.G.I.*

RADIO ENGINEERS' HANDBOOK

By Frederick Emmons Terman, Sc.D.

SUMMARIZING the body of engineering knowledge which is the basis of radio and electronics, the present book stands as an outstanding reference for serious students and engineers. This is no easily read story, but is a compilation of technical material gleaned from practically all the pertinent engineering literature ever published in the English language. Extensive reference to published articles places at the reader's fingertips information on where to find additional data on any specific phase of the general subject. (1020 pages, 5¾ by 9 inches, a large number of tabulations and drawings.) — $6.10 postpaid. — *A. P. P*

Printed in the U S A Press of the Wilson H Lee Company, Orange, Connecticut

Scientific American

Founded 1845

CONTENTS • DECEMBER 1943

COVER: Framed in the lights and shadows of a Wright Cyclone-14 warplane engine gear, is our front cover profile of a modern Rembrandt geared to 20th Century wartime production. This skilled worker in a plant of the Wright Aeronautical Corporation is guiding a high-speed rotary burr over the edges of another reduction gear which soon will harness 1700 flying horsepower. With the skill of an artist, this worker is delicately removing sharp edges without changing the gear's profile even minutely.

SCIENTIFIC AMERICAN, December, 1943 Vol 169, No 6 Owned and published by Munn & Co, Inc, Orson D Munn, President; I. Sheldon Tilney, Vice-President, John P. Davis, Secretary-Treasurer, A. P Peck, Assistant Secretary; all at 24 West 40th Street, New York 18, N. Y Entered at the New York, New York, Post Office as second class matter June 28, 1879, under the act of March 3, 1879 Additional entry at Orange, Connecticut Published monthly by Munn & Co, Inc, 24 West 40th Street, New York 18, N. Y

Subscription rate $4.00 per year. Canada and foreign $5.00.

A message for you...from 1953

(Today, John Jones is just an average American, wrestling with all the doubts and worries and problems that beset every one of us right now. But let's skip ahead 10 years. Let's look at John Jones then—*and listen to him . . .)*

"SOMETIMES I feel so good it almost scares me.

"This house—I wouldn't swap a shingle off its roof for any other house on earth. This little valley, with the pond down in the hollow at the back, is the spot I like best in all the world.

"And they're mine. I own 'em. Nobody can take 'em away from me.

"I've got a little money coming in, regularly. Not much—but enough. And I tell you, when you can go to bed every night with nothing on your mind except the fun you're going to have tomorrow—that's as near Heaven as a man gets on this earth!

"It wasn't always so.

"Back in '43—that was our second year of war, when we were really getting into it—I needed cash. Taxes were tough, and then Ellen got sick. Like almost everybody else, I was buying War Bonds through the Payroll Plan—and I figured on cashing some of them in. But sick as she was, it was Ellen who talked me out of it.

"'Don't do it, John!' she said. '*Please* don't! For the first time in our lives, we're really saving money. It's *wonderful* to know that every single payday we have *more* money put aside! John, if we can only keep up this saving, think what it can mean! Maybe someday you won't have to work. Maybe we can own a home. And oh, how good it would feel to know that we need never worry about money when we're old!'

"Well, even after she got better, I stayed away from the weekly poker game—quit dropping a little cash at the hot spots now and then—gave up some of the things a man feels he has a right to. We made clothes do—cut out fancy foods. We didn't have as much fun for a while but we paid our taxes and the doctor and—we didn't touch the War Bonds.

"We didn't touch the War Bonds then, or any other time. And I know this: The world wouldn't be such a swell place today if we had!"

The Treasury Department acknowledges with appreciation the publication of this advertisement by

SCIENTIFIC AMERICAN

Previews of the Industrial Horizon

By A. P. Peck

BRIGHTENING THE HORIZON

FLUORESCENT lighting, just coming of age at the start of the war, has amply proved itself as an efficient method of illumination in factories and offices throughout the nation. But the surface of possibilities had barely been scratched when practical needs of the moment demanded rapid production for established uses, halting developments along avenues still to be explored. The basis of fluorescent lighting is found in tiny crystals (called phosphors) which, acted upon by invisible ultra-violet rays, give rise to visible light of controllable color and intensity.

A glimpse of the future of phosphors in varied lighting uses is given by a chemico-physicist of RCA Laboratories in the following statement: "Phosphor crystals will display news and entertainment on the screens of our television sets which may be tuned by the light from phosphors in 'Magic Eye' tuning indicators. Kindred phosphors in the screens of microscopes will aid in fathoming the mysteries of bacteria and molecules in order to insure a healthier and happier life for all.

"Other possible uses for phosphors include intense light sources for sound recording and theater projection; indirect illumination wherein the very walls, ceilings, and murals luminesce to illuminate as well as decorate the room; luminescent plastics in thousands of forms to make night-time safer and more colorful; and phosphors emitting specific radiations for treatments of living tissues and organisms."

THE LOST IS FOUND

WHEN main emphasis in technology is being placed on new processes, new developments, it is a bit startling to find an old method of accomplishing a given end being applied with outstanding success to modern precision work in industry. But that is just what has happened in the case of the lost-wax casting process described in detail on page 259.

Much work in metals requires operations to close tolerances. Such tolerances, of an order formerly attained only through precise machine operations, are now being met, in the case of small parts, by the use of modernized lost-wax casting methods. That these new versions will find increasingly wide application in small part production, giving rise to outstanding economies in materals, time, and machine tools, is a future possibility that is well-nigh assured.

BACK TO PEACE

AS HAS been predicted in these pages in past issues, the material benefits of scientific and technological developments made possible by the progress accomplished under the forced draft of military production will eventually reach the general public. This, however, will not take place, by any means, in a matter of days, weeks, or, in most cases, even months. The first post-war industrial production problem will be to turn out goods to meet the needs of a war-restricted nation just as rapidly as possible. To accomplish this will mean resuming production of consumer goods about where it left off when industry went all out for war, and then gradually incorporating those new designs, materials, methods, and so on that have accumulated in the vast reservoir of industrial "know-how."

Confirmation of these predictions is to be found in the attitudes toward the resumption of consumer goods manufacture after the war which are held by two typical companies.

Thus a spokesman for Westinghouse has stated that they plan to resume production of electrical appliances for the home within a few weeks after the war, but that no revolutionary changes in design are anticipated during at least the first year of peace.

In the automobile field, General Motors assures us that they will be able to start production on cars for civilian use within 60 days after the war. These cars, however, will be essentially the same as those which were being manufactured when hostilities forced the industry to convert to full-time military production. Along with this assurance came a carefully worded prediction that, starting with a blank sheet of paper, it would take two years to design and place into production a complete new automobile.

DIVERSIFICATION

A STRAW in the wind of post-war industrial planning is to be found in a recent announcement by a large manufacturer of a wide diversification of interests which will go into effect after the clouds of war have passed from the face of the sun of freedom. Thus, instead of concentrating largely in the radio field, the Crosley Corporation will expand its activities in the lines of home refrigerators and gas and electric ranges and will produce room coolers, frozen food cabinets, and television equipment.

By this diversification it is expected that outstanding economies in distribution will be effected along with increased manufacturing efficiency. This is no case, however, of the shoemaker straying from his last. Rather it is an example worthy of emulation of a shoemaker who applies his skill to include boots as well. It will be noted that the Crosley plans include products in allied fields, where knowledge gained in one phase can be applied beneficially in another.

MEDICAL MARVEL: CHEMICAL CHALLENGE

SAD, at times, are the results of premature and non-critical publicity given to developments of science before the developments have reached a point where the promises stated or implied in the publicity can be met. A case in point is penicillin. Here, undoubtedly, is a medical marvel, but one that still must surmount the long, steep hill of extensive clinical research before its true nature and possibilities can be charted. Furthermore, and equally important, penicillin presents to the chemical industry a production challenge of a magnitude never before faced under the trying circumstances of life-or-death demand. When the chemical industry has solved this tremendous riddle, detailed in the article on page 247, it will have added the brightest jewel of all to a crown already studded with brilliant gems of past performances.

TECHNOLOGY VERSUS POLITICS

WHEN the very important and absorbingly interesting subject of post-war competition between synthetic and natural rubbers is being considered, it must always be kept in mind that here is at least one field where the technologist may not reign supreme. No matter how good for how many purposes, or how inexpensive to produce, may be the synthetic rubber of the future, the politician is very likely to have the last word. Natural rubber, long a juicy plum for international politics, will, when trade is once more established with the Far East and when Latin American rubber plantations are more fully developed, be brought forcefully into the over-all picture. Exactly what is just over the rubber horizon cannot, of course, be foreseen as yet. But that the synthetic rubber industry will have an all-out battle on its hands, with campaigns extending into the inner recesses of political intrigue, is as sure as death and taxes.

50 Years Ago in . . .

Scientific American

(Condensed from Issues of November, 1893)

WATER-POWER — "The Cataract Construction Company has recently awarded to the Westinghouse Electric and Manufacturing Company the contract for building the immense generators, et cetera, for the . . . plant at the Falls. . . . The apparatus will be built in units of 5,000 horse power. . . . The weight of the shaft, turbine and armature is to be carried by the upward pressure of the water columns producing the heads for the turbines. The electro-motive force generated will be 2,000 to 2,400 volts, and will be increased by step-up transformers for long distance transmission and lowered by reducing transformers for distribution. The motors will be the two-phase Tesla motors, which have been found to be well adapted for power purposes."

LIFE-SAVING — "Our life-saving service is admirable in many respects. Its use of light surf boats in place of the heavy life boats used in England is characteristic. The English type could not be launched from our sand beaches. The same thing operates against the use of steam life boats. But where a coast is so notoriously unsafe as that bordering on the bay of New York, it would seem possible for the life-saving department to maintain a steamer ready for instant call to the relief of a distressed vessel, anywhere from Montauk Point to Barnegat. It would also seem possible for more powerful line-throwing apparatus to be provided"

CARBORUNDUM — "From the experiences of the Carborundum Company, crystallized carbide of silicon can be produced at the rate of 150 pounds on the average in a day of 24 hours. The cost of the production is found to be not more than half as much as that of mining and preparing corundum. . . . The chief use to which Carborundum can be put is abrasion purposes. The extent to which emery wheels are employed in factories, mills, and shops has grown most astonishingly, and it is intended that Carborundum should in a large measure supplant the use of emery wheels, on account of its higher efficiency."

EXPLOSIVE — "Plastomenite is the name given to a new kind of smokeless powder invented by Herr W. Guttler. The solution is poured into forms, where it becomes a fairly hard substance, capable of being pressed, rolled, etc. . . . Plastomenite is used for blasting powder, powder for cannons and rifles, signal rockets, etc. . . . The initial velocity from a six and one-half millimeter caliber is 715 meters with a gas pressure of considerably below 3,000 atmospheres."

CAMERA — "A complete little photographic camera, an American invention, eclipses for compactness and novelty anything of the kind that has come under our notice. It resembles in outward appearance a nickel-plated watch, and is readily operated with one hand. The lens is rather minute and of fixed focus, but still makes a sharp, small picture which can be subsequently enlarged four or five diameters."

LIGHTING — "In endeavoring to improve the lighting of his shops at Bolton, Mr. B. A. Dobson naturally turned to electricity. . . . When traveling on the Continent, Mr. Dobson visited some cotton mills, and here he found what seemed a very perfect system of illumination. Arc lamps were used, but they were placed in an inverted position to that which is usual, the negative carbon being above and the positive carbon below. This, of course, threw the greater part of the light rays upward, as most of the illuminating power proceeds from the crater of the positive carbon. The ceiling is kept well whitewashed, so that the light thrown up is again reflected downward. The sides of the room are also whitewashed, in order that a reflection may come from them. The result is that, without any definite source of illumination being observable, the whole room is flooded with a well-diffused light."

GLASS — "We illustrate an improved glass-rolling machine, one presenting striking features of novelty and ingenuity. . . . Its base, built up of plate girders, provides two parallel roller tracks on which the iron and steel bed for

supporting the glass while being rolled traverses back and forth. . . . Duplicate beds on which the glass is rolled are provided, flat tables of metal, one of which only is in the traversing position at a time, the second bed being supported in the rear of the machine in an inverted position, some distance above the traversing tracks. . . . The roller begins to turn, and the end pinions operating on the racks draw the bed and glass toward the rear of the machine under the roller, thus rolling out the molten mass into a plate. When the rear of the machine is reached, the roller is stopped; the upper bed is lowered on top of the hot glass, and the two beds are clamped together. They are then raised, the glass being held between them, and rotated. . . . As soon as the horizontal position is reached, the beds are lowered again on the bearers; the upper one, on which the glass was rolled, is lifted, the roller is started in reverse motion and the plate is drawn back again beneath it, so that the glass is rolled upon the other side."

LIQUID AIR — "Professor Dewar has successfully conveyed a considerable quantity of liquid air from London to Cambridge. The liquid air was carried in one of the double glass, vacuum jacketed flasks, the space between the inner and outer flask containing nothing but extremely attenuated mercurial vapor, together with a little liquid mercury. On pouring liquid air into the inner flask its outer surface is rapidly covered with a mercurial film of extreme thinness, forming a reflecting surface highly impervious to radiant heat."

TELEGRAPHY — "The use of primary batteries in telegraphing has mostly passed away and the dynamo, with its greater steadiness of current and economy, is now employed. . . . In the Western Union Company's Boston office the current is taken in a commutator on one side of the machine, and sent out from a commutator on the opposite side, the transformation being effected by two different windings on the armature."

METEOROLOGY — "One of the most interesting experiments with balloons that has ever been undertaken was that of Messrs. Hermite and Besancon, at Paris-Vaugirard. They succeeded in sending a balloon to the unprecedented elevation of 16,000 meters, or about 10 miles. There were no people in the balloon, but it carried a variety of self-registering instruments designed to record the temperature, the atmospheric pressure, et cetera."

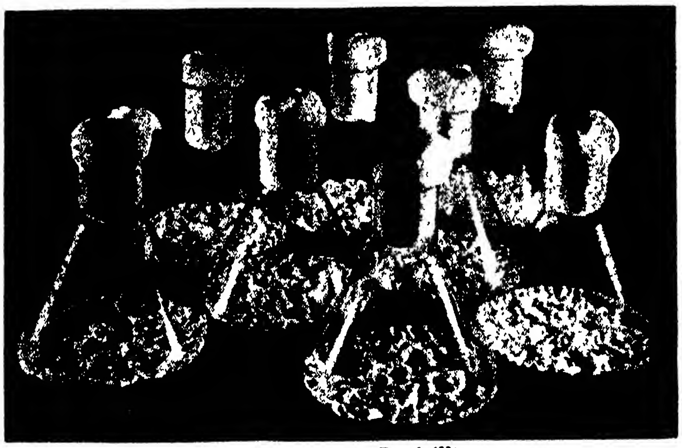
PLEASE LIMIT YOUR CALL TO FIVE MINUTES

When a Long Distance circuit is crowded the operator will say: "Please limit your call to five minutes."

Observing this time limit on essential calls, and avoiding all unnecessary calls, will help the whole war effort.

BELL TELEPHONE SYSTEM

a national problem. Make no mistake, it is a grave problem. *Penicillium notatum* yielding the drug is one of the family of the common blue mold that grows on bread in the kitchen and that gives distinctive flavor to blue cheese. However, the desperate need for production of this drug fails to excite the mold. It pursues its moldy way without the slightest interest in its new task, and infinitesimal quantities of the drug are all that it will yield. Furthermore, the mold refuses to grow under conditions that vary even slightly from its own rather closely circumscribed needs.



The deeply wrinkled mold *Penicillium notatum*

THE MOLD still must be grown in small batches in bottles. Milk bottles are preferred by some growers because they can be washed and sterilized by existing machines. Into each bottle is put the sterile, nutrient broth on which the mold will feed, and a tiny bit of the pure mold is added just before the neck of the bottle is closed with a loose pledglet of cotton. Then it begins to grow and for ten days it is kept in a room warmed to just the right temperature. At the end of that period the surface of the liquid is covered by a deeply wrinkled greenish-gray layer of the mold itself. Occasional droplets of yellow liquid dot its surface. The yellow droplets contain penicillin. So does the broth in the bottle. Painstaking labor is necessary to separate the drug and purify it.

This is all quite complicated and, in terms of the chemical industry's idea of production, highly inefficient. Efforts to devise a continuous process for growing the mold to avoid the complications of small batches in bottles have so far proved unfruitful. They may yet be successful.

No one would question that the drug is worth any amount of money, since it can perform miraculously. Consequently, despite the fact that penicillin is estimated to cost some $18,000 per pound by present methods of production, plants to produce it are being built at a feverish rate. Even at that extravagant cost each dose of the drug costs only about $2, so great is its potency and so tiny the quantity required for a dose. Obviously, production costs must be reduced, and indeed they will be when the nation's output can be measured by hundredweights or tons instead of by ounces as it is today. But, for the time being, methods of manufacture now available must be used until improvements can be devised and put into operation.

Chemical industry, and it is chemical industry that must produce, prefers to find out the exact chemical constitution of the desired material and then make it without depending on or waiting for a mold to grow. But that won't work yet with penicillin. No one knows its chemical constitution. Indeed, no one has yet succeeded in purifying it to the point of being sure whether it is one or several chemical compounds. So great has been the demand for it by military medicine, that not enough has been spared for these essential chemical studies. But that is coming.

In the characteristic American tradition of co-operation, the problems of penicillin are under attack by the most expert team that can be assembled. As this is being written 17 American chemical and pharmaceutical companies are focussing their production facilities and their research efforts on it as a major undertaking. New plants are being built and existing plants enlarged to insure the early availability of the drug. By the time these lines reach the printed stage these projects will be well under way and others may have been initiated.

Some 200 firms are reported to have offered their services. Careful selection has narrowed the number to those best qualified for the undertaking. Significantly, the chosen firms represent all types of experience that can be expected to be useful. Leading pharmaceutical companies come first, since this is a type of manufacture and product that falls easily within their experience. The handling of the mold is itself a special technique closely analogous to

100,000,000 units of penicillin in weighing cubicle

Measuring penicillin potency by Oxford ring test

Courtesy Lederle Laboratories, Inc

The characteristic mold pad which forms on culture medium seeded with spores of *Penicillium notatum*. Droplets of a liquid containing penicillin collect on the surface and accumulate in the subjacent broth. When a maximum amount of penicillin has accumulated, the broth is removed and the penicillin is chemically extracted by a laborious process

industrial fermentations. Thus producers of industrial and beverage alcohol add another type of expertness. Finally, companies with wide experience in synthetic chemistry through the production of synthetic drugs and dyes give the team still another point of view which may lead eventually to the synthesis of the potent compound.

A production team with so varied an outlook gives promise that the problems of providing ample quantities of the vital drug will be solved as quickly as possible. Close liaison between these production units, each with its own experienced research staff, and the several groups of scientists studying the problem, assures that no time will be lost and no field of investigation neglected in the race to this vital humanitarian goal. The whole effort is coördinated by a federal director appointed by the War Production Board to avoid duplication of work and to make every discovered fact immediately available to all.

Thus the miracle of penicillin is well on the way to becoming commonplace It is not commonplace yet.

\+ + +

REDWOODS

Yield Chemical Raw Materials

Redwoods, the mighty giants of the forests of the Pacific Northwest, are joining the chemurgic parade. Long used for lumber, these trees and the wastes from lumbering operations may become the source of many new products as a result of research done by the western redwood companies and the Institute of Paper Chemistry at Appleton, Wisconsin.

Redwood bark fiber is already being blended with other fibers for textile purposes and is also being used as an insulation material. To further utilize the tree wastes, an investigation has been carried out on the chemical composition of redwood bark and has shown it to be composed of cellulose and lignin which is probably the same as in other wood. In addition, there are at least two other products which appear to be high molecular weight—phenolic acids and a form of pectin. Small amounts of two materials named catechal-type tannin and phlobophene are also present. These materials may be recovered and are expected to find many uses in the chemical and chemical specialties industries.

One concrete result of the redwood research is the manufacture of a new, non-critical phenolic type thermoplastic for the production of items formerly manufactured from hard rubber and other thermosetting plastic compounds.

RUBBER PROGRESS

Civilian Tires Will Continue To be Critically Scarce

Grumbling about shortages of tires and other rubber products for civilian use will continue but its end is dimly visible as our synthetic rubber program develops. Reviewing progress, Col. Bradley Dewey, Rubber Director, stated recently to the American Chemical Society that actual production of synthetic rubber in the United States would exceed 30,000 tons a month in September and that all plants required by the program of 850,000 tons per year will be completed in 1943.

Synthetic rubber has grown to be a three quarter of a billion dollar industry in a little over two years, Col. Dewey said, and "that would have been a miracle had it been achieved in peacetime in 15 years." By the end of 1944, he predicted, some 47 million tires would have been made available for essential civilian use—a little more than one and a half new tires per car over the period from Pearl Harbor through 1944—and about a similar number of recaps. All of which indicates that civilian tires will continue critically scarce for some time to come.

MACHINE-TOOL FINISH

Reduces Application Time, Improves Appearance

A new "pebble" finish for machine-tool surfaces not only uses far less finishing materials but can be applied in 1/3 to 1/2 of the time required by usual methods, according to the Sherwin Williams Company. Called a "pebble" finish because of its physical appearance, this new method of protecting machine-tool surfaces solves the problem of "dressing up" a machine surface without fillers, sanding, and numerous coats of sealing paint. WPB officials.

Courtesy the Sherwin Williams Company

New "pebble" finish being applied to a Cincinnati-Bickford radial drill in three operations instead of the seven that were formerly required

in an effort to boost tool output, have prohibited the use of fillers, sealers, and similar finishing materials and restricted the number of coats of paint that could be applied. With the new method, however, it is now possible to finish a machine tool in three operations instead of seven formerly required. The "pebble" finish effectively hides the scratches, grinding scars, and other surface defects on castings. Application of "pebble" finishing is expected to help accelerate post-war planning for improved industrial finishes.

HOME AIR-CONDITIONING

A Post-War Possibility With New Gas-Operated Unit

Post-war homes may be air conditioned by a new type of gas-fired refrigeration unit operated in conjunction with a gas heating plant. One of the important requirements of refrigerating systems for this purpose is that they must employ no flammable or toxic agent to cause trouble in case of fire or accident. The new Servel system employs the absorption principle, using water vapor under low pressure as the refrigerant and lithium bromide solution as the absorbent. This avoids both fire and toxicity hazards.

The refrigeration unit is built as an integral part of a system including the heating plant and the humidity control equipment. The whole operates automatically to hold both temperature and humidity at controlled levels.

Refrigeration is effected by evaporation of water at low temperature and pressure, the vapor produced being absorbed by a strong solution of lithium bromide. After absorption, the water is boiled out of the solution, condensed to liquid by cooling with water from the main, and the cycle repeated. Evaporation of the water takes place in coils in contact with air which is thus cooled and dehumidified before being carried by ducts to the conditioned space.

The unit is not yet available but is already completely planned for large and small dwellings to be produced when peace comes.

Industrial Temperature Control

Many Processes Can be Carried Out More Accurately, Faster, More Efficiently, When Immediate Temperatures are Kept Within a Predetermined Range. This Type of Temperature Control, Often Correlated With General Plant Air-Conditioning, is Being Adopted By a Number of Varied Industries

BACK IN 1910, when the Pratt and Whitney Company, makers of fine tools and machines, arranged to keep their master gage room at exactly 70 degrees, Fahrenheit, they little suspected that they were starting something that would make possible the modern airplane, television, synthetic rubber, high-octane gasoline, and dozens of things that are taken for granted today. There even was doubt that such close control was intended as more than a stunt, undertaken perhaps for its publicity value or to convince the European makers of fine tools that Americans intended to produce enough good tools to hold the import prices down. But temperature control for quality control proved to have thorough Yankee practicality and companies desiring to overcome the difficulties of extra fine production turned their eyes toward it.

As one example, take lenses. German methods of making fine lenses were known here; we even had some of their machines. These machines embodied enough control mechanisms to make them almost infinitely adjustable; their flexibility and versatility was limited only by the sizes of materials which they could handle. It took a good man years to learn to get the most out of one of these flexible production units.

The Minneapolis Honeywell Regulator Company studied these machines. Engineers found that the most complex adjustments were intended to serve just one purpose: To grind to true contours in spite of changes in the dimensions of the glass caused by changes of working temperatures. This problem, of course, could be licked, for Minneapolis Honeywell knew how to control temperatures.

With the more complex adjustments eliminated, the less complex ones were divided into functions. These functions in turn were divided into operations, and simple machines were designed for each operation.

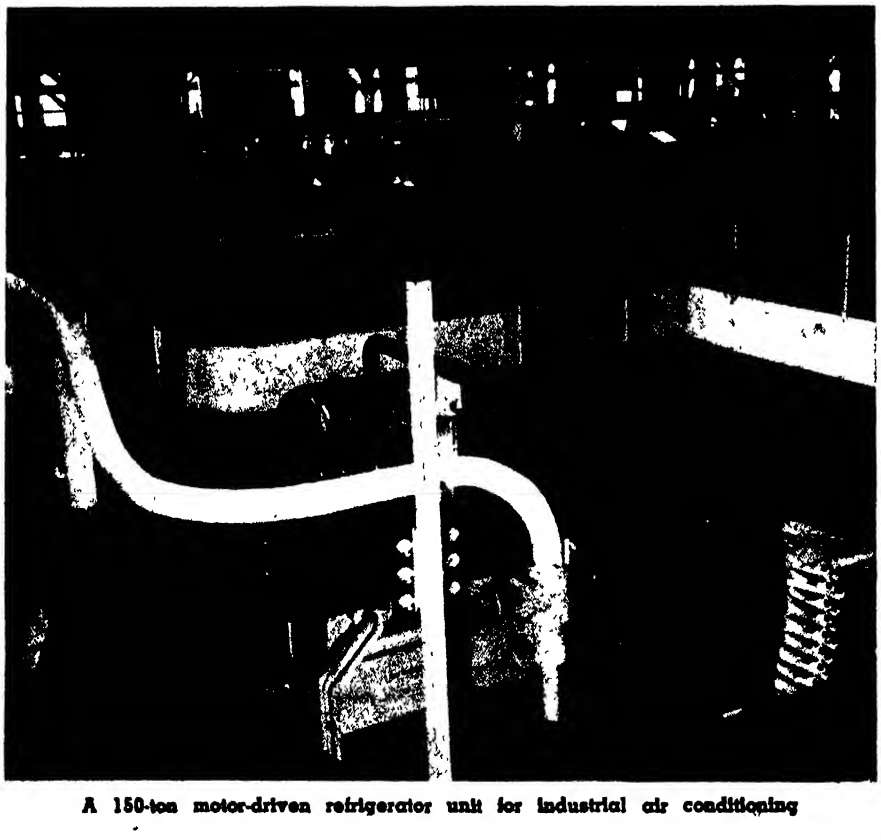
In a short while Minneapolis Honeywell was turning out lenses in quantities which Hitler had believed impossible, and at costs which will prevent good lenses from ever again being classed as jewelry. And far from needing years for man training, most of the production operations could be taught in just two weeks. But this American victory of 1942 dated back to what Pratt & Whitney had done in 1910. Control of the operating temperature of the process itself instead of trusting the workman to adjust his machine for process temperature changes.

In entirely different industries, other lessons were being learned. A large printing plant was one of them. Seeking to do some extra fine lithographic work, this plant brought its entire press room and several tons of paper to constant temperature and held them within a few degrees for several days. At the end of the third day the huge masses of stacked paper and the presses were at the same temperature, and the job began to work as expected.

But over in one corner, something totally unexpected went on. Here was a huge monster of a 45 year old Hoe cylinder press, used only on rare runs of extra large sheets. Everyone took it for granted that this rheumatic old timer would go haywire and have to be readjusted every ten minutes or so But when brought to constant temperature and held there for a day, the old press seemed to be rejuvenated—it started rolling off the work almost without interruption for hours at a time and generally behaving in ways that the oldest old timer in the shop could not remember having it equal in its youth.

It was but a step from these experiences to the practices followed in cutting big turbine gears. The hobbing machines for these are in individual constant-temperature rooms. One gear may take as long as 17 days to cut, yet the work is so perfect that gears several feet in diameter will mate more nicely and work more smoothly than the parts of the finest pocket watches. Each constant-temperature room has its individual air-conditioning unit, with stand-by equipment always ready so that the failure of temperature-control devices cannot ruin a gear worth thousands of dollars.

Many of the largest shops have centralized temperature-control systems, with huge refrigeration and steam generating plants supplying the necessary cold or heat through mains and branch piping. These systems have the advantages of low operating costs and easiest maintenance, all the complex

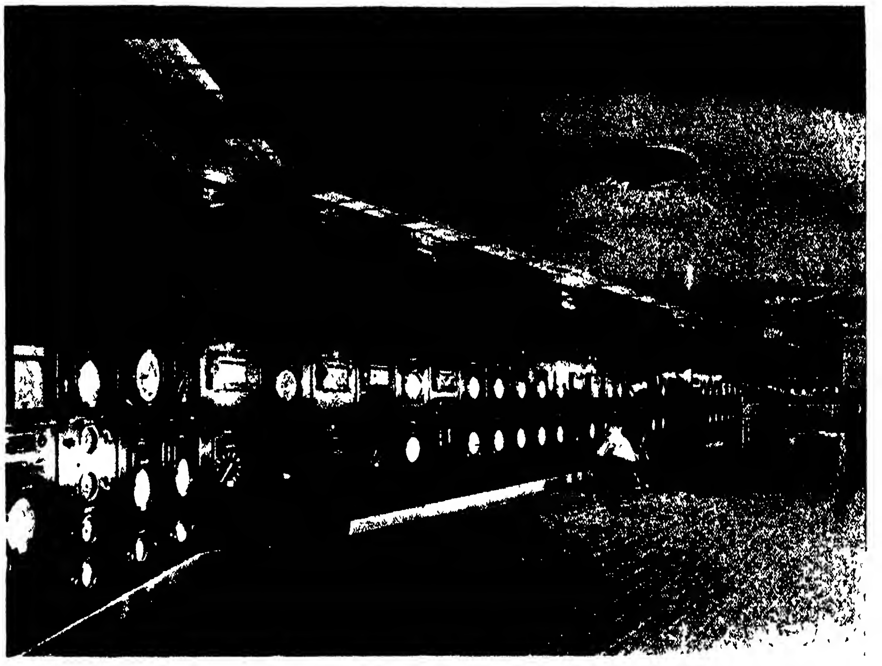


A 150-ton motor-driven refrigerator unit for industrial air conditioning

equipment which needs extensive engineering knowledge and high mechanical skill being in comparatively small areas while the larger acreages of plant space are served by the equipment which plumbers and electricians can maintain. But there is a strong trend toward the decentralized plant which is zoned into areas, each of which is served by an individual temperature control set up. Thus the Douglas Aircraft plant in California has 26 units, each using the same set of its own pipes for distributing cold water for cooling and hot water for heat. Such is the famous California climate that cooling may be necessary for the day shift and heating for the night.

The new Dodge Chicago plant of the Chrysler Corporation has 81 air-conditioning units mounted on the roof to serve 20 acres of floor space in only one section of the plant. Here steel, magnesium, and aluminum parts must be assembled, and since these metals do not expand and contract at the same rates under changes of heat and cold, failure to machine them all at the same temperatures or to have them all at one temperature when assembling would make a mockery of the accurate production demanded of modern war goods.

Unit heater which controls winter temperature within 40-foot radius



This huge bank of instruments controls industrial process temperatures, integrates them with room and general plant temperatures, and records the conditions

The Pratt and Whitney engine plant (United Aircraft Corporation) has 39 separate systems for controlling temperature. Here an activated-carbon device, which acts like a huge gas mask, is used to purify the air which is heated or cooled and to reduce the intake or "make-up" of outside air to the amount needed to supply enough oxygen for breathing. Use of this device has reduced by 80 percent the amount of outside air taken into the plant. And since all outside air has to be either heated or cooled as well as cleaned before it can be used, the savings are plenty. Actually, by permitting the recirculation of some 381,000 cubic feet per minute of air, which otherwise would have to be vented to the outside and replaced, this device reduces by 800 tons of refrigerating capacity the size of equipment needed for plant cooling, and by 33,000,000 Btu per hour the necessary capacity of the plant heating equipment. Some 500,000 gallons of fuel oil per heating season are thus saved.

While close control of plant temperatures has been helping modern machine shops to perform production miracles, a similar development has been going on in the "process industries." The earliest DeLaVergne ice machines—outfits which are museum pieces now—went into breweries and into artificial ice plants. Manufacturers of flammable and explosive products followed along. It was a milestone in temperature control when the Ohio Match Company cooled its factories and worked all summer instead of letting the fire hazard cause it to shut down in hot weather Rayon manufacture is so sensitive that it was made possible only by plant temperature control. And it was natural for milk and other food-handling plants to follow this trend.

But in Newark, New Jersey, was a bakery which seemed able to turn out the grocery-store varieties of bread with less trouble than its competitors. Its methods were closely guarded; no visiting salesmen found out much about them and no trade-paper men wrote them up. Finally the secret leaked out. Rather than controlling only the temperatures inside the ovens and in the shortening and other heat-sensitive materials storage places, this company kept whole process rooms at constant temperatures. The bakers still had a thousand and one variables to worry about—flour and yeast never seem to behave twice alike, even at different hours of the same day—but the number of those process variables was reduced drastically when the temperatures of all materials, all machines which did not employ heat, all air entering ovens, and the surfaces of all heat-using equipment, were always the same. Not only did this make the baking more uniform, but the wrapping machines also behaved better.

Examples like this one made all sorts of process engineers think. They thought so thoroughly that when the problems of synthetic rubber came along, plant temperature control was the natural foundation upon which the solutions of many of them were built. In fact, so necessary was this that the industry could not have come into being without it. The necessary refrigeration equipment did not exist—the processes are mostly heat exuding ones and plant cooling was more needed than plant heating. Large department stores, residences, industrial office buildings, and others gave up their comfort control equipment, sold it to the government at original cost less some 5 percent per year for depreciation, and consented to get along without the increased personnel efficiency and the pleased customer profits it had been yielding, just so that this necessary war industry could get under way.

It was fairly easy to get men to give up comfort conditioning in 1943, for "comfort" is a sissy word in war time. But comfort control is highly important in many types of factories, and for a reason which points up the necessity of plant temperature control for modern production.

Operators who handle many kinds of polished steel parts and nearly all kinds of accurately finished non-ferrous metal parts must not be allowed to perspire. If they do perspire, their fingers will excrete microscopic particles of material which are called "seeds of corrosion." The degree to which this happens varies with operators and with such factors as their diets and their health—it is generally worse with women than with men and is worst during periods of menstruation. These seeds may develop into corrosion areas within a few days, or, if the parts are kept cool enough or otherwise well enough protected, the areas may take months to develop. This was bad enough in peace time when goods so damaged were returned to their makers. But in war time it is not enough to be able to return a jammed cartridge or a faulty bomb sight for credit. The

operators thus have to be kept warm enough to work well but cool enough so that the perspiration will not occur and the seeds of corrosion will not be planted; in short, comfort conditioning for those operators must be nearly perfect.

Machine operators, when first coming on duty, will be contributing about 7 Btu per minute to the general plant heat. The conveyor belt or other pace-setting device before them will be moving at its slowest. Then, as the workers warm up, the pace setter is stepped up also, until at the end of an hour or so it is at the gait which is to be maintained for the shift. Regulated automatically by its thermostats, the temperature control equipment supplies more and more cooling or less and less heat. Machine bearings warm up, electric motors give off most heat as the loads upon them increase and build up their temperatures, furnaces and other heat-employing devices get warmer too, and the operators begin giving off up to 17 Btu per minute each, making the control of their perspiration just that much more difficult. Still the temperature control equipment keeps on regulating itself, so completely and easily that nobody notices that it is there.

One plant which makes fine steel and non-ferrous parts but also has process rooms, tried the experiment of turning off its plant temperature control equipment. The experiment lasted half a day. In that time fine steel grinding machines went out of adjustment and spoiled unusual amounts of work; the oil being fed to the bearings of delicate machines changed in viscosity and the automatic variable speed controls on those machines functioned through wider ranges than ever before; the springs on instruments changed their elongations enough so that operators who trusted them made slight errors; personnel complained of odors from furnaces which they never had noticed before; and everything from metal parts assembly lines to package filling machines and crews slowed down.

Plant temperature control is now costing millions of dollars where ten years ago for exactly the same types of manufacturing processes it would not have cost thousands. But it is returning every cent of this, and with profits. Such refinements of the internal control of processes as the use of potentiometers with whole banks of instrument panels in conjunction with thousands of robot valves to control the temperatures of miles of pipes and tanks in the making of high-octane gasoline; or the holding of cutting oils to constant temperatures so that highly accurate machine tools will not vary in temperatures at their work planes; or the feeding of controlled temperature liquids to the forming dies of presses and the tips of spot welders—all might suggest that the temperatures at the working areas of those devices would be so well controlled that the ambient air temperatures would make little difference. But the exact reverse is the case. The finer the work plane control, the more likely is general plant temperature control to pay dividends.

The factory of the future will be a single unit, a single tool, completely coördinated to the service of its operators. And one of the integrating and unitizing elements in it will be the ultra refinement of general plant temperature control

• • •

INK AND WAR

Many New Inks and Uses Have Been Found by Research

MORE THAN any other fight in history, this is a war of printer's ink.

Inks which will print on metal and not wash off in water nor soak off in oil, are still military secrets, but more than one soldier, taking a military machine apart in the field and lamenting the loss of his repair manual, will find hints, diagrams, and even full instructions right on the surfaces which he uncovers as he removes the bolts.

Reticule printer replaces spiders

Other inks will stay on metals until washed off, but are especially made to wash off completely and easily. They are used to identify parts which might get mixed with others very much like themselves within factories, to warn of variations in materials or in sizes which must be compensated for along the assembly line, and to put template markings on surfaces which are to be cut. They are cleaned off afterwards, sometimes to provide clean surfaces for plating, rust proofing, or other finishing, sometimes to avoid giving information to the enemy if the parts are captured.

Luminous inks for night fighting were used only for watch dials in the last war; they serve now on all sorts of instrument faces and other devices.

Fluorescent inks, which will show up only in light waves invisible to the naked eye, are useful to military devices but like the luminous ones will serve post-victory industry in all sorts of places in which ordinary light either is damaging to the product or is difficult to apply.

Perhaps the strangest development is the printing of fine "reticule" lines on the lenses used in gun sights for war and in surveyors' instruments in peace. Formerly spider webs were the only materials fine enough to be used for these reticules, but when not enough spiders could be found to fight this war a way of printing these lines was worked out. The printed lines are more uniform than the spider webs, and much easier to handle on the production line. And this development of the printer's craft will reduce the costs of thousands of types of industrial and other instruments during the oncoming peace.

MAGNIFYING GLASSES

Are Finding Wide Use in Many Industries

MODIFICATIONS of the ordinary magnifying glass of powers that might be found on the desk of a stamp collector, have crept almost unnoticed into our war plants but are proving to be among the useful tools of industry.

Some objects or points are easier to see with a lower power lens—say two or four magnifications—than with a higher, while higher magnifications are better with others. The same operator may

Better seeing, reduced eye fatigue

need to view the same work through two or more different magnifications, or may need a selection for different items which must be viewed. In many cases the operator has lenses of varying powers within convenient reach.

Uses of these glasses are as varied as the operations of all industry.

Electrical products makers find them handy for girls who weld fine wires together. The glasses eliminate eye strain, make positioning the wires faster and more accurate.

Assembly lines employ magnifying glasses for making sure that small screws or other parts have not been dropped into assemblies which are about to be given running tests, for checking for pin holes and other defects, and the like.

Textile mills, plastics makers, and even wood workers use them to check thread counts, surface finishes, and the spilling or overflowing of cements which might interfere with finishing operations.

Magnifying glasses of these types were rarities in pre-war factories, but will be commonplace in post-war ones.

Conducted by ALEXANDER KLEMIN

A Lighter Age Is Coming

Magnesium is Moving Ahead Rapidly and Now Challenges Aluminum in Many Industrial Applications. Spurred by the Demands of War and Particularly by the Needs of Aviation, American Technologists Have Developed Magnesium Alloys and Fabricating Methods of First-Line Importance

In the construction of airplanes and aircraft engines, there is constant striving to save weight without sacrificing safety. For a number of years, aluminum alloys, because of a combination of lightness and strength, have been considered pre-eminent in the building of planes. Now the availability of the still lighter magnesium has brought a formidable challenge to aluminum.

Why this challenge? Because, while magnesium approaches within measurable distance of the strength of aluminum (45,000 pounds at reasonable elongation in some forms) and has a modulus of elasticity of 6,500,000 pounds per square inch, it is only two thirds as heavy as the next lightest metal used in aircraft, as the following table shows:

Material	*Specific Gravity*	*Weight lbs/cu. ft.*
Water	1	62.5
Magnesium Alloys	1.8	112.0
Aluminum Alloys	2.8	175.0
Steel	7.9	493.0
Bronze	8.8	550.0
Lead	11.3	706.0

Thus the combination of high strength and light weight makes magnesium supremely interesting to the aircraft designer, as well as to designers in other fields of industry.

The enormous growth in magnesium production began quite early in the present war. In January, 1941, before we entered the war, domestic production was approximately four times as great as in January 1940. This enormous growth in production, mainly due to the increasing use of magnesium in aircraft, has been brought about in a large measure by the Dow Chemical Company and the American Magnesium Corporation.

A magnesium sand casting of a type suitable for inlet piping, junctions, and other parts of airplane engines

One of the technologists of Dow Chemical, John C. Mathes, points out that a new plant recently built in Texas represents a remarkable technological development, because the process involves the extraction of its magnesium from sea water. In this process magnesium chloride is first extracted chemically and is then electrolyzed to produce magnesium by a relatively simple and inexpensive process. There is in the ocean a concentration of one part of magnesium per thousand of water. On this basis, each cubic mile of sea water contains over nine billion pounds of magnesium. This supply is inexhaustible and if iron and copper become rare, mankind may find all his needs for metal satisfied by magnesium.

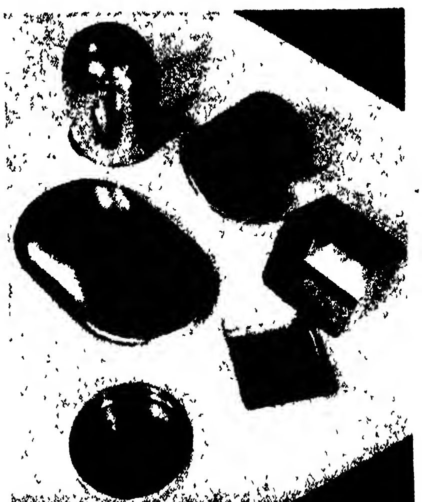
To give the devil his due, the Germans have been pioneers in the metallurgy of aluminum as well as in the metallurgy of magnesium alloys. In using Elektron, as they call alloys of these products, they have led the way. A typical Elektron alloy runs about 6 percent aluminum, 3 percent zinc, 0.2 percent of manganese, and the rest magnesium, with content varying according to the fabrication process—sand casting, die casting, extrusion, forgings, or sheet.

Two German aircraft, the Messerschmidt ME 110, a light fighter bomber, and the Junkers Ju 88, a medium sized bomber—both twin engine machines—fell in England in the autumn of 1940 and were carefully studied from a metallurgical point of view by the Dow Chemical Company. The gross weight of the Messerschmidt was 9900 pounds, and, of this, 300 pounds were magnesium parts. The weight of the Junkers was 24,000 and, of this, 550 pounds in the plane and 300 pounds in the engine were magnesium. The American studies of this magnesium showed high structural strength, high corrosion resistance, and a large variety of forms—castings, die castings, forgings, extrusions, sheet. Compositions used were similar to those in American practice but, contrary to practice in the United States of using most castings in the heat-treated condition, the Germans used a high percentage of the castings in the as-cast condition. Corrosion resistance was somewhat inferior to that of similar materials produced in America. Ultimate strengths and elongations were not far different from ours.

In fact, the meticulous examination showed that from the point of view of metallurgy and fabrication we are not a whit behind the Germans, but it did show that the Nazi designers had more fully realized the potentialities of the metal and were more boldly employing them. Confirmation of this view can be had from a partial list of the locations in which Elektron has been used in either the Messerschmidt or the Junkers or both: Forgings in engine, bearers, supercharger impeller, dive brake, cowl flap; sheet and plate in gunner's seat, wing fairing, other fairings, switch box, compass brackets, and so on; extrusions in a gas-welded fuselage nose structure and the like; castings in the undercarriage supports, in the Jumo engine, in the fuel-tank supports, in the starter assembly housings. And the list is far from being complete.

In one important respect, however, there was complete omission in design. In no instance did these fallen combat planes employ magnesium in primary structural parts such as wing spars or fuselage frame.

It is not solely the war-necessitated increase in aircraft production which has led to greater use of magnesium,



Photographs courtesy Dow Chemical Company

Magnesium alloys can be fabricated in a variety of deep and shallow drawn forms, such as these examples

since the quantity of magnesium alloy per plane also has increased. Aircraft constructors have always sought out light-weight materials and for many years looked with some degree of envy to Germany where Elektron, a magnesium alloy akin to Dowmetal, was used so extensively. But our technicians were suspicious of the reliability of the magnesium alloys and wary of its fabrication difficulties. If the aviation industry has now adopted magnesium alloys so boldly, it is because of four advances: Improved fabrication tech-

nique; better chemical surface treatments; higher purity of the alloys; higher strength of structural alloys.

All the above improvements relate specifically to wrought alloys, but magnesium alloy castings have also greatly improved. The whole magnesium alloy art has advanced because of research by the producers of the metal and by a number of government agencies.

First of all, there has been improvement in forming operations. The forming of magnesium is different from that of other metals because it must be done at high temperatures to eliminate "spring-back." During forming, at 750 degrees, Fahrenheit, the material loses its strength, but on cooling it recovers strength without subsequent heat treatment because the strengh is inherent in the material. The warpage, or distortion, attendant on heat treatment is thus eliminated.

SHALLOW forming of magnesium alloys has been paricularly successful because of the Guerin process using heated steel dies with rubber as the forming medium. (Here also is a process which deserves attention in many industries besides aviation.)

Deep drawing of magnesium sheet at high temperatures has now been developed to a point where, with good dies and hydraulic presses, it can be made to serve in making airplane wheel caps, fairings, oil tanks, and so on—instead of an expensive spinning process. Such parts are well illustrated in one of our photographs.

In aluminum the use of the riveted joint is giving way slowly, but only slowly, to spot welding. In magnesium the technique of gas welding has been developed so that strength is adequate, warpage and distortion are eliminated.

Higher strength has come with an increase in tensile strength to 45,000 pounds per square inch for hard rolled sheet, and to 55,000 pounds for extruded metal. Considering the light specific gravity these figures are extraordinary.

And finally, impurities in alloys have been eliminated to such an extent that corrosion need no longer be feared.

So far we have looked a little backward. The more interesting question is: What is the present status of magnesium in the construction of American aircraft? Here Mr. Mathes, in a recent paper before the Society of Automotive Engineers, gives a very satisfactory picture.

Supplies of ingot, fabrication facilities, and equally important information as to fabricating facilities are fully adequate even for our immense effort. There is now a full choice of suitable alloys; surface treatment and protection are well understood and corrosion resistance is excellent. For some time "stress corrosion" was feared—that is, corrosion of parts under continuous stress. But riveted wings constructed of magnesium alloy sheet have proved satisfactory, and there are other indications that stress corrosion need not be feared.

Methods of joining are excellent. Aluminum rivets mav be used for joining magnesium, or spot welding may be employed with due protection against effects of weathering. Arc-welded joints are also in wide use.

Service experience has been favorable. Millions of pounds per month of magnesium castings are going into frames, engines, doors, panels, and floorings in the airplane, and no adverse reports seem to be coming in.

Gun-fire is important in combat aircraft, and considerable research has been carried out with regard to its effect on magnesium structures. Regarding explosive shells, Mr. Mathes makes these interesting remarks:

"Explosive shells are more destructive to magnesium structures than to aluminum structures. Our observation has also been that solid shots into a large liquid container, such as a gasoline tank, produce an effect similar to an explosive shell and cause more damage to the magnesium surrounding it than to aluminum. Perhaps paradoxically, the British have had a very satisfactory use of magnesium as gas tanks in their Spitfire airplane. These tanks are constructed as a welded framework of extrusions with the sheet welded in, patch fashion, as small panels. Their observation is that these tanks are not only considerably lighter (12 gallons more capacity and 9 pounds less in weight) than the aluminum tank previously used, but are also more resistant to gunfire because the magnesium does not 'tulip' and prevent the external bullet-proofing rubber from sealing effectively. Such tanks are reported to be readily repaired."

Finally, there is the question of primary structures. Several airplanes have been designed, built, and satisfactorily tested both statically and in vibration. A few have reached the flying stage and stood up well. The British are using magnesium sheet as covering for control surfaces and over portions of the wing on some planes with complete satisfaction. In an advanced trainer in which an outer wing has passed tests, 11 percent of present construction weight was saved. With an aileron 26 percent was saved, compared with aluminum.

Of course, it should be said in fairness that aluminum alloy also is not standing still, that its strength properties are constantly advancing and that the proponents of aluminum are by no means conceding superiority in structural weight to magnesium.

Aviation has drawn support from almost every one of the applied sciences. In return it has taught much to other industries, and one lesson which has been taken to heart by such industries is that of lightness. All transport equipment, for example, has profited by the example of the airplane, with great improvement in performance brought about by the use of lighter metals. Ships, trains, bicycles, have all profited in this manner. High-speed engines in marine and automotive work are employing light alloys in reciprocating and revolving parts to great advantage. Magnesium has appeared in chemical containers and has been used for bobbins and spools and for engraving plates which often must be sent as first-class mail.

Under stress of war our magnesium resources have been greatly multiplied, and our methods of handling it greatly improved.

More magnesium in aircraft will shortly mean more magnesium in many industries.

A lighter age is coming for the United States.

And when we say that a lighter age is coming, aviation is definitely included.

Our brief survey indicates that we have actually surpassed the Germans in the metallurgy of magnesium and that, while we have lagged behind them in its application, we shall now forge ahead of them since we are making use of magnesium in primary structural parts which they do not appear to have undertaken. Magnesium will be used in greater proportion in the metal aircraft to come.

We may also venture the prediction that, besides the more extensive use of magnesium alloys in other industries, the special fabrication processes which have been developed may have an influence on the working of other materials.

* * *

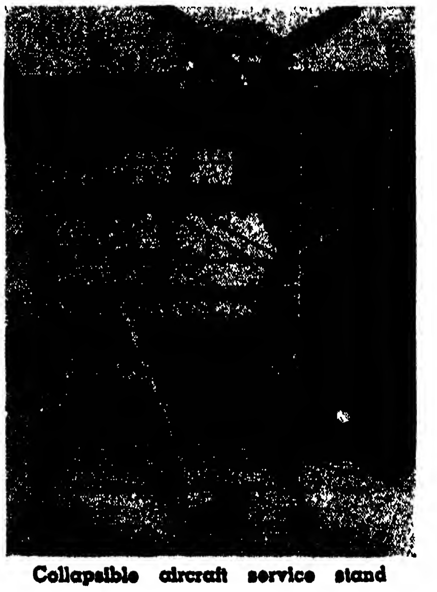
SERVICE STAND

Aids Repair Work,

Folds into Small Space

AN AVIATION repair stand, adjustable to shape and heights of wings, fuselage, or tail assembly, developed by Wolfe and Mann Manufacturing Company, can be erected quickly without the use of a single tool and can accommodate as many as half a dozen mechanics. It is provided with ball bearing casters and can be easily rolled about and then locked firmly in position. Because it can be folded into small space to slip under the wings or for moving into the hangar, the stand can be shipped in a package of small dimensions.

Viewing the picture, one might think



Collapsible aircraft service stand

Artist's conception of the Martin cargo plane described below

that this is not a very difficult piece of engineering, but the stand is nevertheless a very useful accessory and one which our Army Air Forces are putting into service in several war theaters.

SAFETY IN FLIGHT

Increased by Minor Precautions

THE CIVIL AERONAUTICS BOARD analyzes flight accidents, gives the reasons for such accidents, and suggests precautions for greater safety. Over the years it is found that such analyses and records will do a tremendous amount to increase the safety of American flying. From time to time the C.A.B. draws on its wealth of gruesome (and sometimes ludicrous experience) to write a Safety Bulletin.

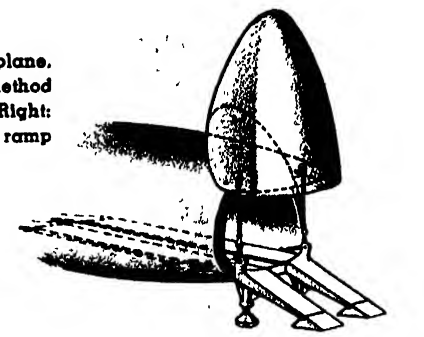
Here is a humorous but worthwhile paragraph: "In acrobatics or gusty air the pilot who flies a plane containing an accumulation of loose articles such as cushions, earphones, maps, a loose portable radio, a chute, or even ordinary dust and debris like nuts, bolts, pieces of safety wire on the floor or in the corners may find himself in the position of the fellow who tries a handstand with his pockets full of change—but probably with more dire results than the loss of a few coins."

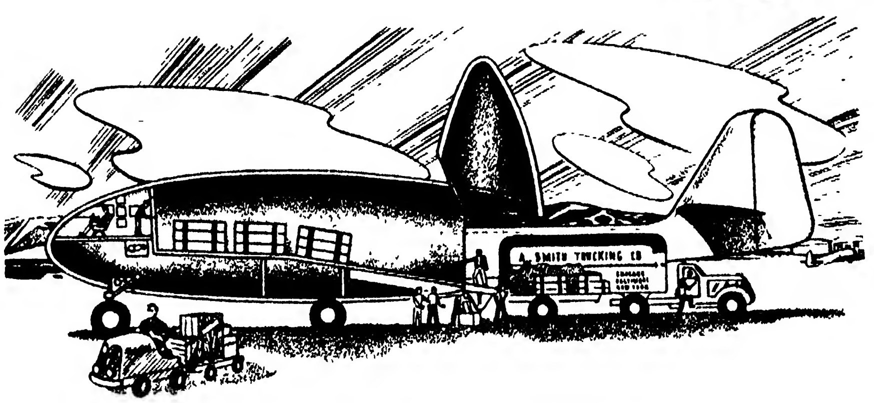
Violent movements of the plane may follow from gusts, and sometimes the pilot absolutely must execute a violent maneuver such as a sharp bank. The C.A.B. accordingly gives this fine rule: "When an aircraft is released from a repair depot or from a factory, go over it with a vacuum cleaner to get rid of small loose objects, and check the interior of the cockpit or cabin for loose objects before every flight."

NOVEL CARGO PLANE

Designed for Rapid Loading and Unloading

WITH THE increasing importance of air cargo will undoubtedly come airplanes designed specifically for such duty and differing considerably from the almost conventional passenger transports. Thus, William D. van Zelm of the Glenn L. Martin Company has patented an arrangement which is illustrated in the accompanying sketches.





Below: Sectional view of the new cargo plane, showing the pilot's cockpit up front and the method of loading through the rear of the fuselage. Right: The open cargo door and the collapsible ramp equipped with adjustable jacks

One of the sketches shows a four-engined airplane, in which the customary long fuselage is replaced by a relatively short fuselage and two long booms supporting the tail surfaces. The pilot's cockpit is up front, but the rear part of the fuselage can be swung upward as shown in the second sketch so as to give the freest possible opening for large cargo. This arrangement also permits a truck to drive close up to the loading door.

A tricycle landing gear is incorporated in the design, while another feature lies in a hydraulic mechanism which is used both to raise the cargo door and to extend a collapsible ramp which can be adjusted to run either to the ground or to the back platform of a truck. The ramp itself is equipped with adjustable jacks close to the point where it hinges to the plane, so that the cargo does not exert any strain on the structure itself during loading operations.

The tricycle landing gear permits the plane to remain level during loading or unloading; thus it should be possible to load automobiles or other wheeled freight directly aboard the plane.

The four-engined plane shown in the design is to have a gross weight of 86,000 pounds and a useful load of 36,870 pounds of which 13½ tons would be cargo.

SUPER GAS

Increases Engine Power Some 50 Percent

BAD NEWS for the enemy is contained in a recent announcement by Dr. Gustav Egloff, President of the American Institute of Chemists, of the commercial perfection of a motor fuel called triptane, which has raised engine power half again over 100-octane gasoline.

Triptane is said to be the most powerful hydrocarbon known for use in the internal-combustion engine. Its antiknock properties are also remarkable. Thus, in addition to furnishing more power, the new gas will allow the use of greater compression ratios on the airplane engine which, in turn, means more specific output and greater efficiency. Triptane has been known for several years, but it is only now that it can be made in quantity. It used to cost $3000 a gallon; now, in a relatively small pilot plant, its cost has been reduced to $1 a gallon.

The advantage of such a gas to combat airplanes can scarcely be overemphasized. The Germans are said to be employing some method of "doping" their engines to produce a burst of power and speed in an emergency, but the method ruins the engine. Triptane holds great advantages in this regard.

Color Matching in Industry

Photocells and Tubes, Taking Up Where the Human Eye Fails, Make Possible Accurate Matching and Measuring of Colors, Leading to Applications in Many Fields. In Colorimetry Standard Colors are Eliminated and a New Scientific Tool is Provided that Promises Much for the Future

By JOHN MARKUS
Assistant Editor, Electronics

COLOR is a mental concept induced when radiant energy of certain frequencies falls upon the retina of the human eye. Many words have been coined in attempts to describe and define the concepts caused by different frequencies, but the futility of securing precise and unmistakable terminology is evident when one considers that under favorable conditions the normal average human eye can distinguish at least 5000 different colors.

Color standards, especially pieces of colored glass, might seem to be the answer, but even if it were possible to assemble a complete standard set of colors there would be no assurance that the different colors would remain constant for any period of time.

To complicate the problem still further, color appearance is not always what it seems. Three variables affect the color concept telegraphed to our brain by the retina—our own visual characteristics, the kind of illumination on the color sample, and the optical characteristics of the sample—and each can cover a wide range of variation. Optical characteristics include such things as the amount of each color that is absorbed, the amount reflected, and the amount transmitted, as well as the nature of the reflection. A mirror-like (glossy) surface gives what is known as specular reflection, while a powdery, irregular (dull) surface gives diffuse reflection.

With plastics and other recently developed materials which now are making color an increasingly more important factor in industry, the problem of getting exact colors for particular products has logically been turned over to electronic engineers. To be sure, the optical spectrophotometer has been used for many years in laboratories to measure and match colors, but it still remains strictly a laboratory instrument, too slow for the needs of industrial engineers.

An optical spectrophotometer requires that a large number of individual observations be made to secure the necessary data for plotting a permanent color record known as a spectrophotometric curve. These curves represent color specifications or analyses that are the same for all observers and all conditions of observation, because they involve comparing the radiant energy reflected or transmitted by the sample at each selected wavelength of light with an absolute standard of reflection or transmission.

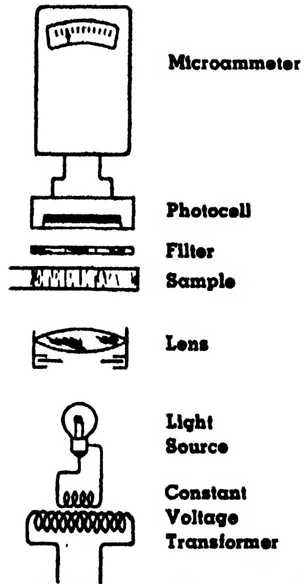
Recording photoelectric spectrophotometer made by General Electric in the laboratory of Interchemical Corporation, where it is used to establish color for inks, paints, enamels, and so on

Because of the complication of the optical spectrophotometer, electronic engineers took over the job of providing these color data in a matter of minutes rather than hours, independently of human errors and in a manner suitable for production-line use. How well these engineers have done their job of meeting the widely varying requirements of electronic color comparators, colorimeters and spectrophotometers in hundreds of different industries is indicated by the fact that available units now cover the entire gamut of photoelectric colorimetric instruments from the simplest $55 comparator to a mammoth and almost human $6400 version, all meeting precision requirements of particular jobs for which they were designed.

An electronic color comparator determines whether a color sample reflects or transmits the same amount of a given light as does a standard sample. In general, this comparison is accomplished by making the comparison four times—first with white light, then with three primary colors in succession. Sometimes white light alone will detect a non-match, but no single light will give assurance of a good match. Only if the standard and sample reflect or transmit equal amounts of white, red, green, and blue light to the phototube or light-sensitive cell is there reasonable assurance that the two objects will appear to have the same color under all ordinary illuminations.

Photoelectric color comparators find widespread use in many industries. In the textile industry, they are used to measure Fade-ometer and Launderometer results, to detect mis-match of dyes, to detect color errors that might be caused by weave texture, sheen, or surface texture; they also are employed to compare samples of paints, powders, pastes, coffee, food, and other colored materials or liquids. Knowing in what portion of the visible spectrum a color sample differs from the standard, it is often possible to estimate what color pigments or materials should be added to the sample to make it match the standard color.

A typical comparator arrangement consists of a single light source providing two identical beams of light, one directed through or reflected from the



Diagram, very much simplified, of a typical photoelectric colorimeter

standard color onto a phototube or light-sensitive cell, and the other directed through or reflected from the color sample onto another phototube or cell. The two phototubes or cells are connected into a resistance bridge circuit containing an indicating galvanometer that shows whether or not the two light-sensitive devices are receiving equal radiant energy.

A PHOTOELECTRIC colorimeter in its simplest form consists of a light source, a beam-forming lens, a sample holder, a filter holder, and a self-generating photocell positioned to receive either the light transmitted or the light reflected by the sample. The photocell is connected directly to the indicating meter, usually a galvanometer or microammeter. Here the meter deflection is proportional to the amount of light reflected or transmitted into the photocell. Many variations of this basic arrangement are in use, some with additional refinements to provide greater accuracy.

As with comparators, colorimeters employ filters to permit measurements at a number of different portions of the visible spectrum. For a set of three primary colors, three filters are usually standard accessories. Their colors are such that no two of them will combine to make the third, yet the three will combine to make white light. There are a variety of color combinations which meet these requirements, but those most commonly used are red, blue, and green.

With three filters, it is possible to specify the color appearance of a color sample in terms of equivalent stimuli of the three selected primary colors. These relative stimuli values are called tristimulus values.

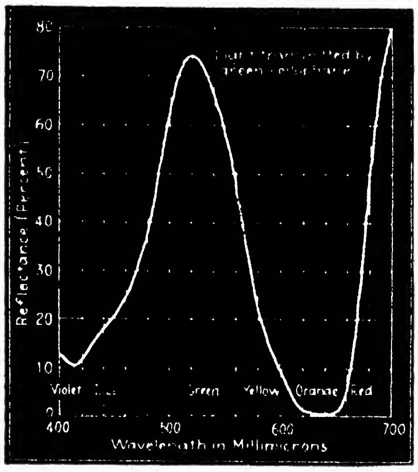
A set of three red, green, and blue primaries has been designated by the International Commission on Illumination as ICI primaries, and readings obtained with these filters are known respectively as X, Y, and Z tristimulus values. An additional feature of these ICI primaries is that fact that the Y tristimulus value gives the luminous reflectance of the sample directly in values from 0 to 100 percent.

In at least one instance, it is possible to obtain a set of 14 different filters for a photoelectric colorimeter, permitting isolation of the visible spectrum into wavebands each approximately 30 millimicrons wide, and giving in effect an abridged spectrophotometer. From the set of 14 values obtained with these filters one at a time, it is possible to plot a spectral transmission or reflection curve approximating the continuous curve provided by a recording photoelectric spectrophotometer, or select a filter most suitable for repeated tests of a material in process control.

If a mercury-vapor lamp is used as the light source, transmission measurements in the invisible ultra-violet region can be made with some types of photoelectric colorimeters. This feature is particularly useful in measuring the vitamin-A content of liquids.

In general, a colorimeter is designed for transmission measurements. Instruments for measuring various types of reflection from colored samples are sometimes called photoelectric reflection meters.

Some work has been done with infra-red spectroscopy, in which the amount of invisible infra-red light reflected or transmitted at various infra-red frequencies is measured with a sensitive thermopile (which converts radiant heat energy directly into electrical energy by thermoelectric means). This measuring technique is useful regardless of whether or not the material appears to have color, because certain seemingly transparent materials definitely absorb characteristic portions of the infra-red spectrum. The method has been already used for controlling the manufacture of synthetic rubber and its raw materials, for dealing with colorless petroleum derivatives, and



Example of a spectral response curve obtained from green cellophane with the recording spectrophotometer shown on opposite page

for studying the molecular structure of organic substances.

One interesting wartime application of photoelectric colorimeters is a compact Westinghouse instrument that monitors the color of the blood in a flyer's ear, and indicates when additional oxygen is needed during high-altitude flying. A tiny light and midget phototube supported on opposite sides of the ear lobe by a spring clip provide an output current that is proportional to the color of the blood and hence to the oxygen content. The output of the phototube is amplified and fed to an indicating instrument and sometimes also to an alarm.

Vast new fields for electronic measurement and control with photoelectric colorimeters are opening up in photoelectric chemical analysis, biochemical analysis for clinical purposes, metallurgical analysis, vitamin industry control, color control in beer and other liquors, process control of foodstuffs, determination of various qualities in blood, and so on. The chief reasons for the great success of these electronic instruments are speed of observation in comparison with older visual methods; lack of fatigue of phototubes or photocells; the full sensitivity in the

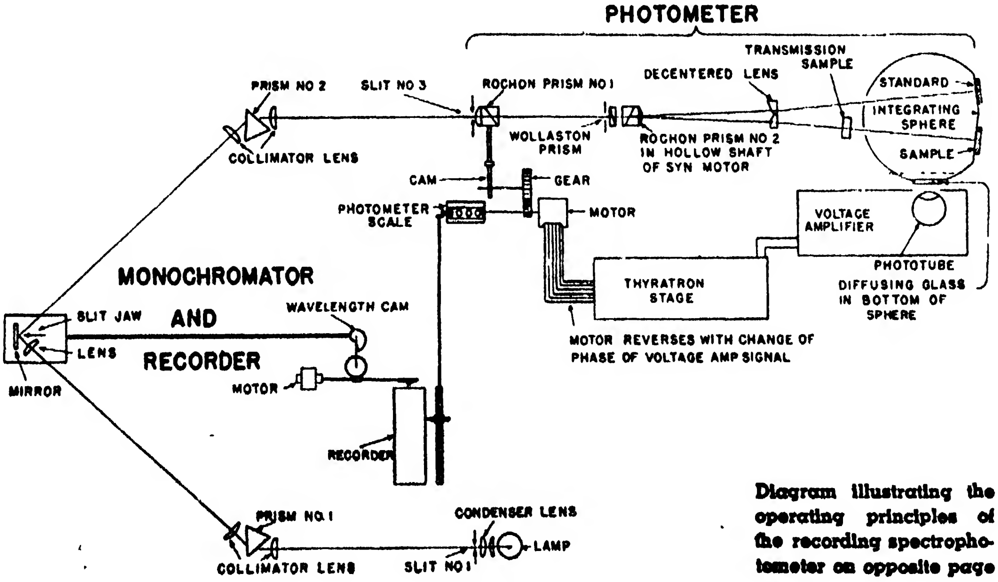
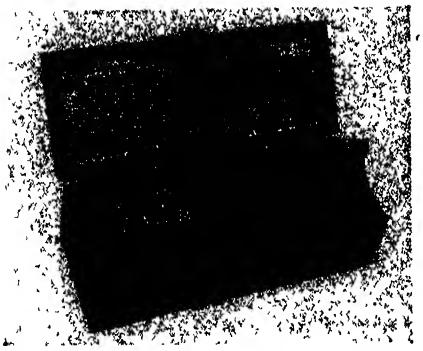


Diagram illustrating the operating principles of the recording spectrophotometer on opposite page



The Photovolt Corporation's photoelectric colorimeter, an example of a unit in the $100 price range

end regions of the visible spectrum and even beyond; the feature of automatic operation in some instances; the fact that electronic instruments do not require trained observers; and the fact that measurements are made without need for darkening the room.

The recording photoelectric spectrophotometer developed by General Electric Company engineers from the original design by Professor A. C. Hardy, of Massachusetts Institute of Technology, will measure either reflectance or transmittance, as desired. It quickly and accurately analyzes and records any color that is visible to the human eye.

THE INSTRUMENT consists essentially of a monochromator, a photoelectric photometer, and a recorder. In the monochromator, white light from a lamp is spread into spectrum colors by a first prism, and reflected by a rotatable mirror into a second prism that spreads the colors still further. The light at the output slit of the monochromator is a pure 10-millimicron wide band of colorded light, the wavelength of which is determined by the position of the reflecting mirror.

The resulting monochromatic light passes through two Rochon prisms and a Wollaston prism that collectively generate two beam components, mutually perpendicularly polarized, which fall respectively on standard and sample inside a photometer sphere. The light intensity varies from minimum to maximum on the sample and on the standard, which are out of phase with each other, due to mechanical rotation of one Rochon prism by an electric motor.

A phototube views a frosted glass in the wall of the integrating sphere, the brightness of which is proportional to reflectance for both sample and standard. When the light reflected from the sample is not equal to that reflected from the sample for a particular spectrum band, an A.C. component is present in the phototube. This is utilized through a thyratron stage to rotate the other Rochon prism enough to remove the A.C. component from the phototube. The angular position of this first Rochon prism is thus a measure of the reflectance of the sample in terms of the standard. This angular position can be read directly on a scale, and also used to actuate the recorder which provides the spectral response curve of the color under study.

The discoloring of an organic finish during service governs to a large extent its quality and usefulness. With the spectrophotometer, the effect of such factors as heat, light, ultra-violet radiation, humidity, and grease upon paints and other finishes can be quantitatively determined by accelerated life tests or by tests at regular intervals under actual use. Tests such as these are being used more and more by military and governmental purchasing agencies as well as by industrial firms as reliable guides in the purchase of finishing materials.

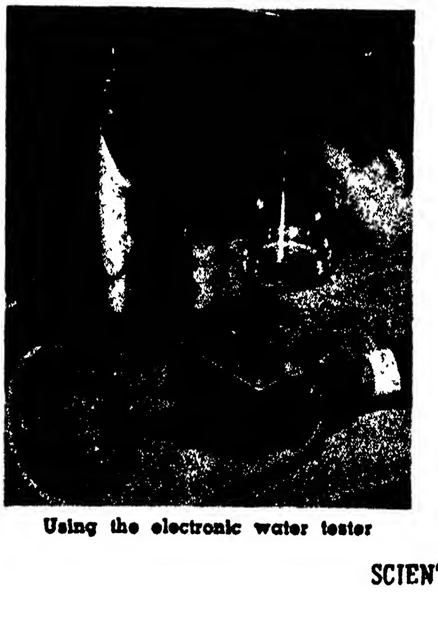
In colorimetry, applications are much the same as for the other instruments, with the spectrophotometer providing a more nearly accurate result, giving the transmission for each wavelength in the visible spectrum so that any one wavelength may be considered to the exclusion of the others. This is important because the human eye integrates over the entire visible spectrum, and interfering colors often make accurate visual comparison difficult or impossible. The instrument also eliminates the use of standard colors for each determination, and provides an absolute permanent record that changes colorimetry from an art to an exact science, gives analytical chemistry what is virtually a new tool, and promises much for the future in all industrial processes related in any way to light and color.

⊕ ⊕ ⊕

WATER PURITY TESTER

Uses Electronic Tubes to Measure Conductivity

A COMPACT electronic device employing a cathode-ray tuning indicator tube and a rectifier tube has simplified the process of testing distilled water to the mere act of inserting a conductivity cell in the water, adjusting a knob for maximum shadow of the electric "eye," then reading the purity on a scale. The instrument actually measures the electrical conductivity of the water under test, but for convenience the scale is calibrated 0 to 15 parts per million in terms of sodium chloride so that the user obtains a direct reading.



Using the electronic water tester

The circuit is essentially that of an alternating-current Wheatstone bridge, with the conductivity cell and the liquid in which it is immersed constituting the unknown resistance.

MOTOR CONTROL

Multiplies Usefulness of Ordinary Drill Press

THE FIELD of usefulness of the ordinary small drill press may be greatly increased by the addition of a 1/3 horsepower thyratron control. Operating speeds can be adjusted from 25 revolutions per minute to 1750 revolutions per minute simply by rotating a knob, and the direction of rotation can be changed by pressing a button. Independent speed adjustments are provided for both forward and reverse rotation, permitting preselected speeds for both tapping and backing out. The range of speeds makes it possible to use the drill press for a wide variety of hard-to-drill materials from molded compounds to the hardest steel pieces without changing pulleys.

COAL MINE EYES

Electronics Takes the Place of Child Labor

PHOTO-ELECTRIC cells have been in use for some time in coal mines for the obvious purposes for which many industries have employed them—that is, for opening doors and for protective devices A new job for the photo-tube has now been found—that of the old symbol of child labor, the "breaker boy."

Coal, after coming up from the ground, is sorted; that is, slate, "bony" coal, and other undesirable refuse, are removed. Instead of picking it out by hand, more progressive colleries have devised mechanical means for performing this cleaning job. Nowadays the coal plus refuse is dumped into a trough of water which is agitated by compressed air. Since coal has a lower specific gravity than slate and other undesirable material, the coal floats and is taken away. The heavier materials, however, fall to the bottom and in time pile up so that they must be removed. Here is where modern engineering enters the picture.

The refuse makes contact with a sensitive free-moving float made of aluminum and weighted so that it conforms to the specific gravity of the material to be drawn off. This float rises as the refuse material varies in depth. Attached to this float is a vane which intercepts a beam of light until the refuse becomes high enough so that the beam is no longer eclipsed. Then it shines into a photoelectric cell, the output of which sets into motion a mechanism controlling a rotary gate.

By this means continuous and automatic discharge of the unwanted materials is effected. A second photo-tube speeds up the motors if the refuse piles up faster than the preliminary gate can handle it.

Found: The 'Lost-Wax' Process

Once Employed Chiefly for Accurate Manufacture of Small Metal Jewelry and Dental Parts, the "Lost-Wax" Casting Process Has Been Modernized and Adapted to War Production. It Now Looms as an Important Precision Method for the Post-War Production of Small Metal Parts

If there is one ancient adage that this war has repeatedly disproved, it is: "You can't teach an old dog new tricks." The ultra-modern uses that old stand-bys like cast iron and wood have been given would astonish even some foundrymen and carpenters; even more remarkable is the wartime rejuvenation of one venerable metal-working art, the "lost-wax" casting process, and its sudden emergence as an industrial metal-forming method of new significance for post-war manufacturing.

The unfolding story of the present and future applications of the lost-wax process must be superimposed on a background of the recent trials and tribulations of its parent, the jewelry manufacturing industry. Few industries were in so desperate a plight 20 months ago as was this one. Classed as non-essential, it was properly denied an important part of its raw materials, while its manpower began an exodus to industries and operations that were contributing directly to the war effort.

Independently and in groups the jewelry manufacturers appraised their worsening situation and sought means by which they might participate in war production. One of the groups was the Jewelry Crafts Association in New York, whose president, William B. Ogush, fixed upon the lost-wax centrifugal casting process hitherto used only for the accurate manuacture of rings, mountings, dental forms, and so on, as a likely method of making precision parts for ordnance and aircraft which would simultaneously save tons of raw materials and thousands of man-hours in production time. His association formed a sub-contractors' pool and together with some independent manufacturers demonstrated very quickly to Ordnance engineers that the lost-wax centrifugal process could indeed go to war, that its new name "precision casting" was highly appropriate, and that the use of the method and equipment as already installed in several shops would provide a welcome alternative to tedious machining for making many sorely-needed parts.

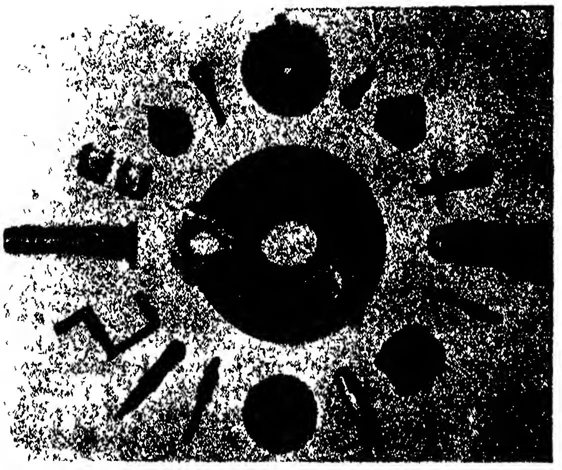
Thus, through industrial application of this old-new process, many jewelry manufacturers have been able to stay in business and to bring the day of Victory just so much closer. But of nearly equal importance is the certainty of most of them that the use of the lost-wax process for making precision *industrial* parts is here to stay. As one of them stated: "Production men with an eye to the future are studying this process now for its possibilities in the mass production of small parts for the automobile accessory industry, outboard motor, refrigerators, and allied fields."

The first thing revealed by these studies is that several variations of the lost-wax process are now in use. In its simplest form the operations are carried out something like this: First a stock sample of the part to be manufactured, a bevel gear, for example, is obtained and employed as a master pattern to produce a master mold or "wax mold" whose cavity is a replica of the solid part. This master mold is in two parts (to permit removal of the stock sample and later of the wax pattern) and may be made of low-melting bismuth alloy, rubber, plastics, and so on. The soft metal or plastic molds are preferred because they can be made directly from the part by pouring the mold material around the latter in a suitable container.

Photographs by Walter B. Much

Making the wax pattern in the lost-wax process

Pouring molten alloy in a precision casting machine



Precision parts made by the process described

Into the cavity of the master mold is then poured a special wax to form a wax facsimile of the part to be cast. This wax form is removed and transferred to an otherwise empty flask, and around the wax is poured the "investment"—liquid plaster of Paris, for example—which is then allowed to "set" or harden. When dehydrated, the investment is heated to melt the wax, which is then poured off to leave a plaster mold capable of accurately reproducing the contours of the sample part when the metal of the final casting is poured into its cavity. The plaster mold is broken up during removal of the finished part.

It is at once evident that the virtue of and reason for the wax is that it can be so simply removed (merely by melting) from the mold cavity of the investment, however complicated and undercut the latter may be, without breaking or marring the final mold in the slightest. In the general art of casting no other "pattern" customarily used to form a mold is so simple in nature and so easily removed as wax, and indeed it is this feature—the melting away of the wax pattern—that gives the lost-wax process its name.

The modern variants of this process all include centrifugal casting of the metal finally poured and introduce sundry improvements in the wax or investment material employed. The fanciest centrifugal casting machines in use whirl the electrically-heated melting-crucible and flask as one unit in a horizontal plane, instead of spinning the mold about an axis running through it, as in centrifugal casting of pipe. The machine is set in motion when the metal to be cast is molten in the crucible, which is located directly behind the flask on an arm of the machine. As the machine spins, centrifugal pressure forces the liquid metal into the mold cavity, where it solidifies.

The compositions of wax and investment are closely guarded trade secrets. Waxes may run from beeswax to synthetic compositions, with much interest now being shown in certain injection-molding thermoplastics and even in very low melting point alloys as improvements over traditional waxes. Special centrifugal wax-casting machines are often used to achieve the ultimate in accuracy of reproduction.

Instead of plaster for the investment, ceramics of various types may be used. One company has developed a refractory investment whose high-temperature properties permit its use for casting high-melting metals like stainless steel and other ferrous alloys.

The size of the casting machines used varies, the most popular having an over-all diameter of about 40 inches. A labor force of two workers is all that is required for one machine, and a single machine may produce, through multiple molding, many castings in each operating cycle. A typical machine cycle, from loading the investment through removal of the flask, requires about three minutes. The daily output of one station on a casting machine often reaches 200 to 300 parts.

Part sizes are still small, dimensions of about 3½ inches on a side being the usual maximum feasible at present. On the other hand, the precision available in the process is very high; tolerances of 0.001 to 0.002 inch can easily be met, and in the tiniest parts it is not uncommon to hold tolerances to 0.0005 inch in all directions. In almost all cases the only finish-machining required is removal of the gates.

In the manufacture of ordnance and machine parts, the castings are most commonly made in non-ferrous alloys and stainless steels with only a relatively small (but growing) volume in engineering alloy- or carbon-steels. Best results are obtained with strong bronzes like manganese bronze, aluminum bronze, or beryllium-copper, and with aluminum alloys, zinc alloys, and stainless steels.

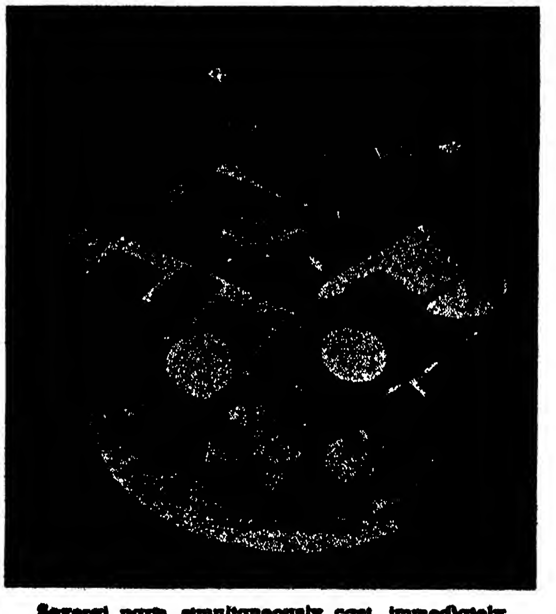
Once acquainted with the nature of the process, its technique, and its engineering feasibilities, the alert engineer translates these into terms of broad production and design advantages and limitations. He notes the latter first: Precision casting by this process has definite size maxima, as mentioned earlier. It cannot generally be applied as yet to the more common ferrous metals. For production runs amounting to tens of thousands of a single part, other fabricating methods involving permanent dies or molds would probably be more economical. Determination of master-pattern and wax-mold shrinkages, the selection of wax and investment material, and the correction of distortion in thin parts are individual problems that must be empirically solved for each case.

But the advantages, on the other hand, seem worth the effort: The dimensional accuracy possible is unsurpassed by any other casting method, and the most complex shapes and surface contours can be reproduced with high precision. Usually no machining is required to produce the finished part and this has led one observer to describe the process as combining the foundry and the machine shop in one art.

In addition to all the machine time, man-hours, tooling, and waste material saved by the process wherever it replaces the machining of bar stock, or of forging, or of sand casting as a production method, it has important subsidiary features. The raw material can be secondary ingot metal, ideal from the national conservation point of view and also subject to quicker delivery than bar stock or forgings.

Some of the present applications of the process will serve to illustrate its capabilities and provide a background against which to estimate its post-war horizons. Theoretically almost any shape or contour produced by machining can be duplicated by lost-wax precision casting. Tapped and threaded surfaces, gear teeth, undercuts, tapers, holes of all shapes—any of these alone or in combination with others—can be cast in one unit (the process cannot compete economically, however, with stamping or screw machine fabrication on a mass-production scale).

A typical case history is that of a 1½-inch diameter bevel gear formerly machined out of bronze bar stock and ordered in 4000-piece lots. By the former method 80 man-hours tooling and eight minutes production time were required; lost-wax centrifugal casting in Tobin bronze necessitated only 30 man-hours tooling and six minutes production time. But here are items of even greater significance: In producing the machined part 60 percent of the original stock went into the scrap barrel as chips and turnings, as against only 2 percent scrap by precision casting. Furthermore, the delivery time for the bar stock was 21 days from the



Several parts simultaneously cast, immediately after removal from the casting machine

time of ordering, while the ingot metal for casting was received three days after the order was placed.

At the opposite end of the production-volume scale is the case of a 3½-inch diameter aluminum-alloy compressor head of which only 250 units were required. Machining required 250 man-hours tooling and 120 minutes production time and resulted in 55 percent turnings waste. Precision casting tied-up only 40 man-hours for tooling, 30 minutes for production, and produced only 3 percent scrap—in addition to reducing the inspector's rejections for excessive porosity from 25 percent of total production to only 4 percent.

Another view of a group of simultaneously made castings, showing complexity of the unit parts

Many other cases could be cited. In addition to the busy field of ordnance parts, some of the most successful new applications of peace-time significance include beryllium-copper bearing mounts, bronze pinion gears, stainless steel surgical instrument handles, aluminum alloy engine-starter parts, stainless steel supercharger turbine blades, and so on. Millions of non-ferrous parts and hundreds of thousands of ferrous pieces have already been produced by industrial firms using the lost-wax centrifugal casting process.

The future is full of promise for this precision casting method. In the highly competitive period that will follow the war, manufacturers will overlook nothing that can cut costs or that will permit the accomplishment of results not otherwise easily obtainable. Precision casting will appeal to some because it decreases waste and speeds production. It seems destined for increasing use for the fabrication of small parts to be made of metals whose melting points are too high for die casting, of shapes too complicated for powder metallurgy, and of dimensional tolerances too narrow for sand casting.

And it may hold the solution to many new and important designs that could not be commercially produced by the usual fabricating methods because of their intricacy or complexity. What *that* means to both Victory and post-war planners can plainly be seen.

● ● ●

HEAT-RESISTANT ALLOYS

Are Low in Critical Metals, High in Strength

One of the hardest conservation nuts for our engineers to crack has been the special group of alloys employed for turbines, furnace parts, oil-refinery equipment, and so on, because of their superior resistance to weakening and to oxidation at high temperatures. High in critical chromium and nickel (usually 5 to 20 percent chromium and 35 to 8 nickel), these materials have so far seemed unreplaceable by other metals without sharp loss of high-temperature resistance.

At a recent meeting of the American Society for Metals, however, it was announced that for service in the most important temperature range (up to 1400 degrees, Fahrenheit) a new "emergency" heat-resistant alloy was entirely satisfactory and could replace the widely used 18 percent chromium, 8 percent nickel, and 25 percent chromium, 12 percent nickel alloys with considerable saving in critical-material content. The saving is achieved by replacing a large part of the nickel and chromium with silicon and manganese.

The new alloy, developed by O. E. Harder and J. T. Gow of Battelle Memorial Institute, contains 10 to 13 percent chromium, 4 to 10 nickel, 2 to 12 manganese, about 2 silicon, and between 0.30 and 0.35 carbon.

With the nickel and manganese contents properly balanced, the new alloys have sufficient high-temperature toughness for the customary rough handling while hot in the foundry and yet are low enough in hardness to be machinable. The strengths of the alloys at 1400 degrees, Fahrenheit, are substantially higher than those of the commonly-used heat-resistant alloys at 1800 degrees, Fahrenheit.

Here is an "emergency" alloy development that is obviously destined to outlast the emergency.

BRAKE PISTONS

New Materials Being Tested For the Future

A revealing glimpse of what lies ahead in the field of automotive brake materials is afforded by some recent remarks of J. F. Bachman of Chrysler Corporation.

Brake cylinder pistons have very often been made of aluminum alloy, but wartime stringencies have forced engineers to use other materials, and some of them are definitely "here to stay." Tin-plated cast-iron pistons, for example, have turned out to be at least as satisfactory and certainly less expensive than aluminum.

Tin-plated steel and plastic with hardened steel inserts have also been successfully used and may survive the war period. Steel pistons, however, create a difficult handling and inspection problem because of the possibility that tiny burrs or nicks may scratch the cylinder bore and cause leakage. The plastic-and-steel pistons are still "under observation."

GUN BARRELS

Made from Seamless Tubing For 75mm Artillery

For decades, artillery gun barrels have been made by forging on large presses, a time-consuming operation followed by considerable machining, especially to make the bore. Then, a few years ago, Army production engineers developed the centrifugally-cast gun barrel, which is cast virtually to finished size and shape in a revolving mold. Centrifugally cast barrels can be produced much faster than forged, involve a minimum of waste metal to be machined away, and are cheaper to make.

Since the beginning of this war a brand new method (generally referred to until very recently simply as "Method X") has come into use for high-speed production of artillery gun tubes. This method, which is the fastest yet, consists of piercing an axial cavity in a long hot billet by means of piercing rolls, sizing by broaching, and then surface-finishing.

Columbia Newsphoto
A gun barrel in the making

The method is in use at the Steel and Tube Division of Timken Roller Bearing Company, who are thus applying their knowledge of and equipment for making seamless steel tubes for various peace-time purposes to this important ordnance item. Piercing the hole in the hot billet takes 15 seconds and broaching is a relatively fast operation. The former practice of drilling a tough, heat-treated, solid forging alone required six hours.

The use of existing seamless tube mills for making gun barrels has eliminated the need for building dozens of new forging hammers and presses and hundreds of gun-boring lathes. In addition, the pierced steel tube is not only closer to finished dimensions than a hammer-forging, but the metal that would be cut out of the bore and returned to the mill as shavings is retained in the tube, actually part of the gun's wall.

Music in Industry

Management is Learning that There Was More than Mere Romance in the Old-Time Work Songs and Music. Psychologists and Engineers Show that Music Powerfully Controls Workers' Emotions and Even Their Physiology. The Factory Music Distribution System Increases Production

By HAROLD BURRIS-MEYER
Stevens Institute of Technology

AMID dislocations brought about by industrialization, one of our serious losses lies in the fact that music—the old sea chanteys and work songs—has gone out of work. When you separate work and song, you make work out of work.

The kind of data from which it can be determined what music actually does to workmen have proved to be sadly lacking. Instead of facts we have hearsay, hunch, and theory, all readily available in almost any quantity. Managements which use music and employees who listen to it seem to agree that music is a fine thing. Organizations which install electronic distribution systems and furnish programs have files full of letters from satisfied customers. There is a growing popular belief in this country that music in a factory can do just about everything except rearrange the stockroom or interpret the latest set of government regulations.

Evidence to show how good industrial music is, based on casual or superficial observations, is freely adduced. Everybody who gets his hands on a plant music distribution system at once becomes an expert and can tell you everything about programming, speaker placement, intensity levels, what the boss thinks about it, what the employee thinks about it, how little either of them knows about it, and what a good thing it would be if somebody had consulted him first. Employers sometimes ascribe to their employees their own reactions and opinions. One company gave up playing music because it interfered with the factory inter-communication system. An official of another would not install a system because, said he, "if I get it in and I don't like it, the employees will never let me take it out."

All this adds up to precisely nothing we can use. Even a report published by the Medical Research Council of the British Industrial Health Research Board is of limited use because, though the studies it treats are thorough, they apply only to a group of girls working in a chocolate factory.

Our interest is in emotional control. We are interested in exerting it directly by emotional stimulus, and by inducing physiological change as the basis for emotion. In industry the ends to be achieved by emotional control obviously are: To suit the man to his task; to give the work the status of a calling; to make it for the man, not what he lives by, not that which produces the pay envelope, but a major element in living. If that can be done, even if only in part, the work improves and the employee likes it. If you have control of the stimulus, if you can define it in terms of intensity, spectrum and cyclic quality and then measure the rate and quality of production, lateness, early departure, absences, accidents, and any discoverable indices of employee morale, without the worker's knowledge that he is a subject, you have a valuable technique for the study of emotional control and can, incidentally, find out what music in industry is good for, and how good it is.

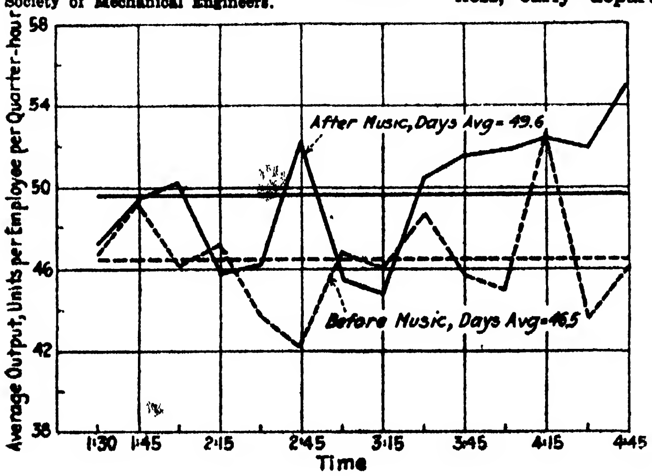
As a starting point, there is a considerable mass of physiological and psychological data. By auditory stimuli, we can control metabolism. We can increase or decrease muscular energy. We can increase respiration. We can increase or decrease pulse rate. (Try that on yourself sometime. Take your pulse while you sing: Change the tempo of the song and you will observe a change in your pulse rate). We can control the threshold of sensory perception, and this is very important in precision work. We can reduce, delay, or increase fatigue. By the control of these phenomena it is possible to establish a physiological basis for the generation of emotion.

Unfortunately, the phenomena I have mentioned have been studied only under laboratory conditions. The subject often knew that he was a subject, and that somewhat conditioned his response. Moreover, he was not engaged in his principal activity while being tested, nor did he share his reactions with a group. The extremely important phenomenon of mass reaction has been neglected. Obviously, then, even our basic theory when applied to music in industry needs validation in the factory.

Accordingly we proceeded to study existing musical programs in factories, and then to assemble programs for specific purposes. It has been our good fortune to have the co-operation of numerous industries and of two organizations dealing in factory music distribution systems and music libraries—Muzak, Inc. and Radio Corporation of America. Lacking the kind of factory records susceptible of statistical analysis for our purpose, we had to get them ourselves. The data we have are indicative. They are not sufficient to form the basis of unassailable conclusions, but we believe they show which way the wind blows.

We set about to measure the most obvious thing—does music in the factory influence the production rate? All the charts here presented were drawn from data taken under controlled conditions. No figures are used where

From a paper presented before The American Society of Mechanical Engineers.



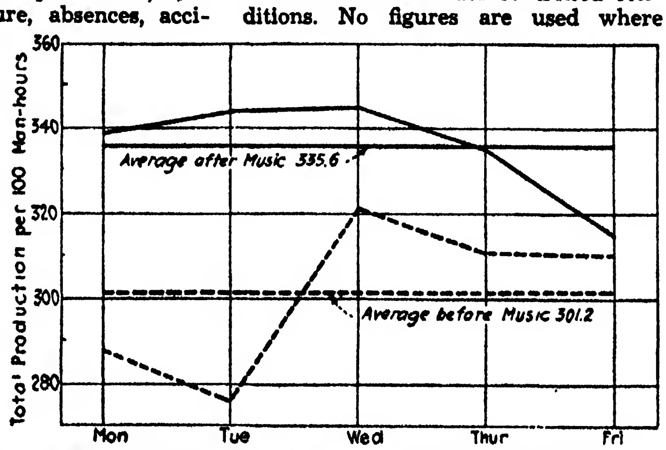
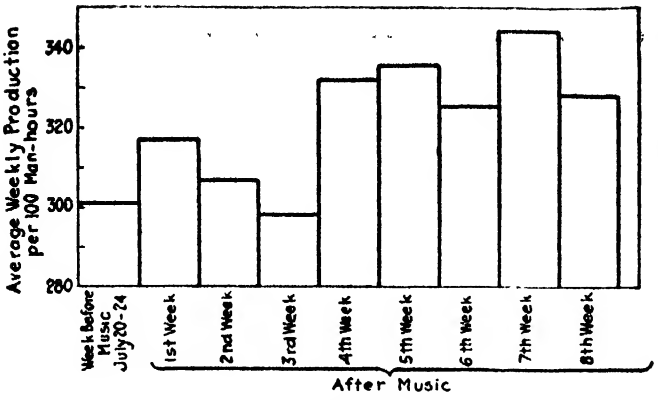


Figure 1, left: Effect of music on a day's production
Figure 2, above: Effect of music on a week's production



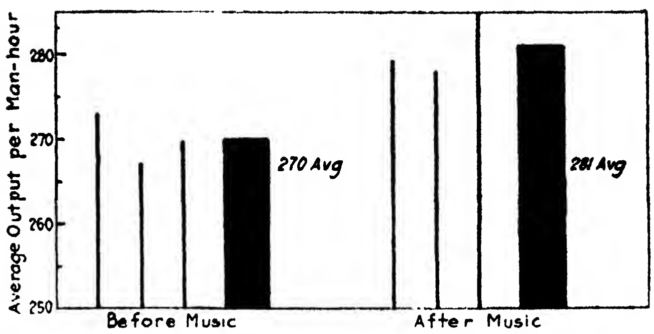


Figure 3, left: Effect of music over several weeks
Figure 4, above: Another result over several weeks

there were significant changes in weather (temperature, humidity, light), or ventilation, or noise, from day to day; or where there was other than normal labor turnover, or any labor-management quarrel; or where there was any plant change in terms of machine arrangement or color, or any variation in the process or the product.

Figure 1 shows the unit output per employee, plotted against time. The dotted curve shows a day without music, the solid curve a day during which music was used. The conditions prevailing on the two sample days were identical in temperature, humidity, ambient noise level, ventilation. The group consisted of 16 experienced employees. Both curves are erratic, but the horizontal line which defines the total area under the curves is considerably higher where music was used than where it was not. The difference amounts to 6.25 percent, based on the average before music. In more than 75 percent of the measurements of this sort in all the factories studied, we have found the area under the curve, or total production, to be greater when music is used than when it was not used.

Figure 2 shows the total production per 100 man hours during two typical weeks, one before and one after a music installation was made, and represents the average for a group of approximately 100 employees of all degrees of experience. The difference amounts to 11.4 percent.

Figure 3 shows what happens to production when musical installation is made. Each block represents the average production per 100 man hours in one week. In only one week was the average production lower after music was used than during the control week before musical installation.

Figure 4 shows a similar result in another factory. In the case of the latter, the operation studied was one requiring a very high degree of manual dexterity and a sense of timing. Employees were on piece work as in the case of Figure 3. The average difference is 4.07 percent. Each line represents a week, and the blocks show the average during the periods of study.

These charts would seem to indicate then that music makes work go faster and, since all the foregoing graphs were made where piecework prevailed, the employees profited by the changes introduced by the music

A CONCOMITANT of the production rate is the problem of Monday absences and early departures with which some industries have to contend. Figure 5 shows what happened in a plant where the employees were on piecework and where they got tired and went home early, before the musical installation was made, did not do so much of that when there was music to listen to The graph shows two sample weeks and an average before the musical installation; and four weeks and an average in which music was used.

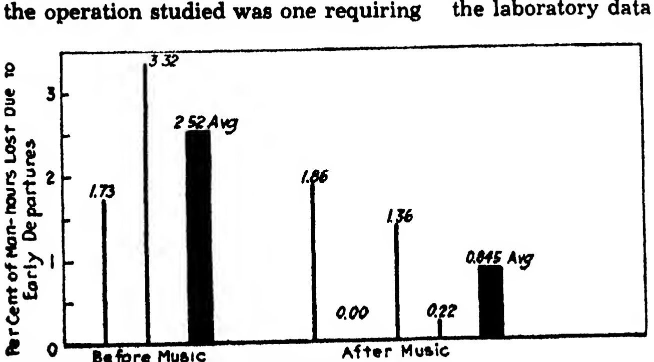
Figure 6 shows what music does to Monday morning absences The lines show the percentage of absences per week for four average weeks before, and four after music installations were made; and the blocks show the four week averages.

In the case of all graphs, of course, averages have been computed from a base of a similar total number of employees. No data are included which are not based on identical plant, metereological, noise, and light conditions.

Having answered definitely, though for not too many factories, the question of what music does to the production rate, we set about examining the *kind* of music and *when* it was played Programming is, as may be deduced from the laboratory data on auditory stimuli, of great importance. It is now practised in conformity with theatrical principles plus observation and experience. These serve well as a starting point, but are not susceptible of being weighed, measured, or analyzed by statistical means, and there is a considerable divergence of opinion among those who arrange programs on the question of the number and length of playing periods; the relative values of associative and non-associative music; the value of popular jitterbug versus classical music; the relative value of vocals and instrumental music.

It is generally accepted practice, however, to limit playing time to not more than 2½ hours per day, in periods of 12 to 20 minutes. Marches for opening, and marches and popular foxtrots for change of shift or closing time, are most generally preferred Music during the last 20 minutes of work period is generally not employed since it might be taken as a signal to get ready to go home Special radio programs, especially those planned for music in industry, are occasionally used "Deep in the Heart of Texas" is out. It stops all work in the United States and in England because, naturally enough, the employees feel obliged to drop all work to join in the hand-clapping in the chorus The "Strip Polka" is shunned for obvious reasons Hymns are said to be in considerable demand on Sunday in some factories, though it has been observed elsewhere that hymns can *stop* work about as fast as a fire gong.

Luncheon periods are considered the most flexible in programming and often carry recorded messages to the folks back home from the men in service, bond sales talks, news reports, hot numbers for the jitterbugs, salon music alleged to aid digestion, request numbers, and so on. Some factories ban vocals during work periods, others like them.



All drawings courtesy "Mechanical Engineering"

Figure 5: Here music reduced mid-afternoon homegoings

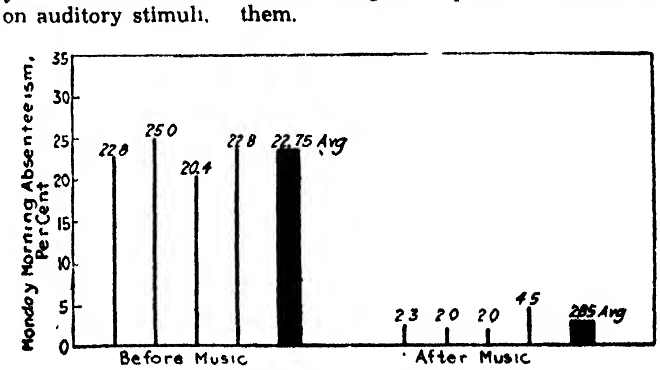


Figure 6: What music did to Monday morning absences

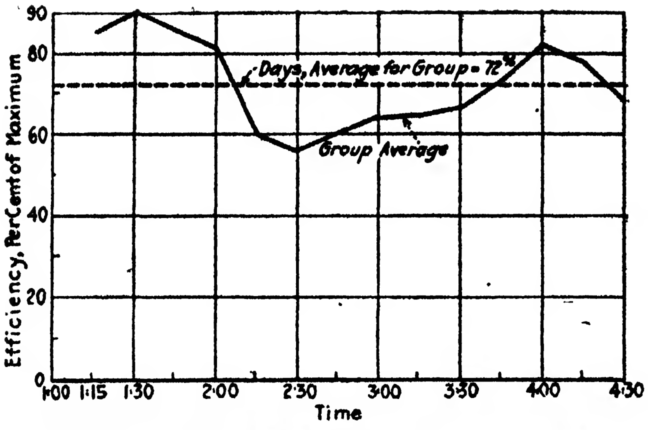


Figure 7: An afternoon production curve before music

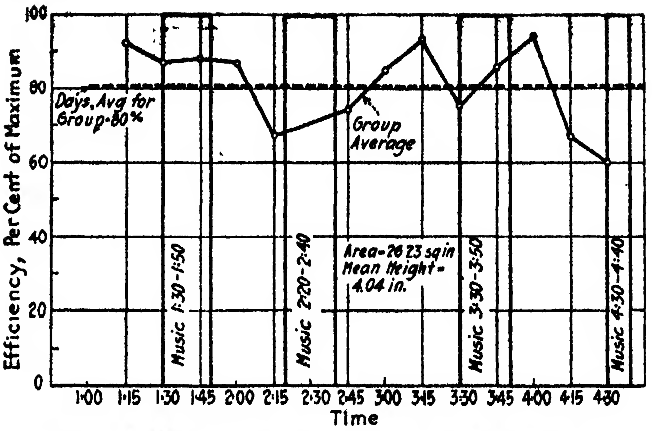


Figure 8: Effect of music, same period, same company

Employee demand for music rises at night, and music is a source of comfort during blackouts. One factory played "Take Me Out to the Ball Game" as the World Series started, and announced the score every third inning.

It is obviously impossible to make the value of many of these program elements the subject of statistical analysis. But the mere diversity of the opinion and material seems to indicate that one kind of program ought to be better than another, especially in the case of a specific set of conditions or type of operation.

So far as I can discover no one has gone down to bed rock on the subject. The empirical development of a system of programming would be all right if records of results were kept. The development of a program from psychological and physiological data at hand is another approach to the problem of programming.

We have been able to undertake only one experiment in this field designed to demonstrate that a musical program planned for a specific purpose can accomplish that purpose. The factory has had music for six months. Programming was provided by the organization which installed the distribution system and was, so far as we were able to evaluate it, a better than average program. It consisted of numbers especially arranged and recorded for industrial use, was arranged on the basis of experience and observation, and reproduced with high-fidelity equipment.

We were unable to obtain any production figures of our own for the period before music. However, we went back to some records which the company had kept approximately one year before this experiment took place, and, although we cannot vouch absolutely for the conditions obtaining at that time, we believe that Figure 7 provides a fairly representative picture of what their production curve looked like at that time. The average here is 72 percent. As the subsequent graphs will show, there was an increase of 8 percent with the installation of music, and 14.8 percent with a planned test music program.

The production curve, Figure 8, showed a reasonably uniform pattern involving a sharp dip at approximately 2:15 in the afternoon. The test program was planned with the sole purpose of knocking the bottom off the 2:15 dip. Figure 8 is based on a typical day with the standard program and Figure 9 a typical day with the test program. On the second chart the 2:15 dip has been reduced approximately 20 percent, also the total day's production (area under the dotted line) has been increased in the case of the test program 6.8 percent. This would seem to bear out a theory to which I have long subscribed, which is that, while music is better than no music, programming will not be satisfactory until it is undertaken on the basis of a careful analysis of the results it gets. More statistical analysis of factory performance should teach us much.

I believe that programming must ultimately be undertaken for the factory, if not for the specific operation. Fatigue curves vary in shape and amplitude, and it is difficult to find one remedy for dips occurring at different times in different operations. We have, at least, established the fact that the remedy exists and the technique for employing it is in hand.

Whether we like it or not, music in industry appears to be here to stay and bids fair to be of increasing importance as time goes on. It has been indorsed by responsible officers of both the A.F. of L. and the C.I.O. Factory sound installations are now mandatory in England. This is primarily to avoid loss of time in the case of air raids by not calling the employees out until the last moment, but so far as I can discover, more factories appear to use the systems for music than do not. Numerous radio stations here and in England carry musical programs planned for broadcast to factories. Once the sound system is in, music comes in with it. The number of factories employing music in this country grows so rapidly that statistics of this week are no good next. Installations progress and programming improves. Music works but we still have a long distance to go before we can make the work sing.

Little of the music used in the factory is germane to the endeavor it accompanies. The work song took not only its rhythm but its mood and lyric from the work operation. The transcription carries something composed for the concert hall, the stage, or the night club. At best, it is only adapted to industrial use by reorchestration and arrangement. When the composer starts to think of his work as being first and oftenest performed in a factory, before people who are working while they listen; when he proceeds as some composers are already doing, by treating proved auditory emotional stimuli according to musical pattern; when he sets himself the task of making the work sing, then we may well have a musical idiom which is something new on earth.

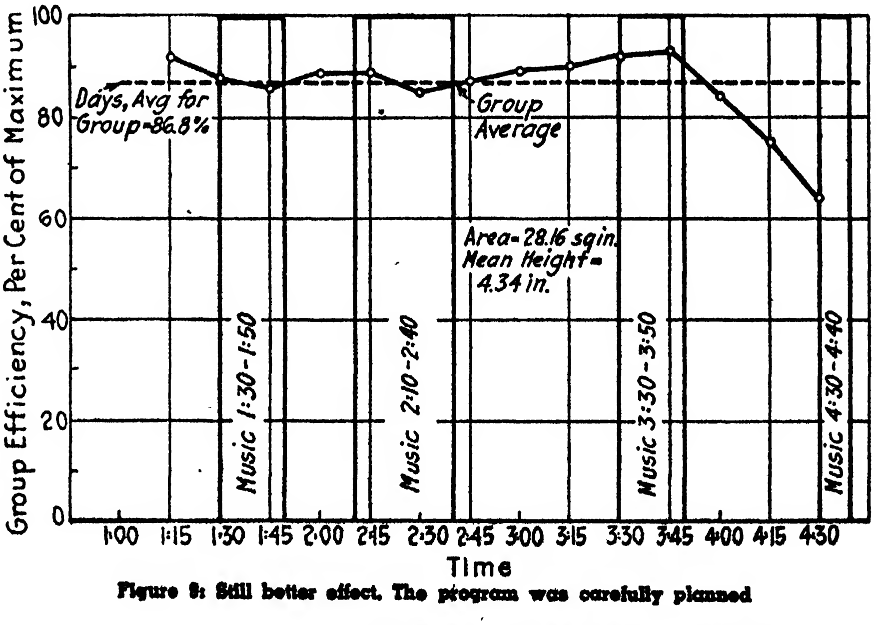


Figure 9: Still better effect. The program was carefully planned

Felt Goes To Work

Either Alone or in Combination With Other Fabrics and Natural or Synthetic Substances, Wool Felt is Being Used in Many Industries. Some of Its New Alternate Applications Will Find Permanence in Post-War Days

By WORTH COLWELL

MONTHS BEFORE our entry into World War II it became apparent that shortages of certain vital materials would be inevitable, and industry began to look around for products that would take the place of such necessities as rubber, cork, leather, rope fiber, tin, shellac, and certain plastics requiring critical chemicals in their processing or manufacture. As defense plans in December 1941 suddenly evolved into a gigantic offensive program, the demand from a multiplicity of diversified sources swelled to astronomical proportions. One of the answers to this demand was found in wool felt, a commonplace, unspectacular, natural-fiber fabric—in fact, the oldest fabric known to man. Through intensive research and experimental effort, this old-new material is now finding uses in many ways that were unexplored before pressure was brought to bear.

Felt has thus become an important alternate and complement for many vital substances, especially rubber. And because of the successful applications that have been found for the material alone and in combination with other substances, wool felt now is regarded as a factor to be considered in the post-war economy ahead; in many cases it has proved superior to the material which it supplanted.

Just how many civilian and military uses there are for this product is not known precisely. Certainly no other material manufactured from natural fibers finds so many ways to make itself useful in mechanical and industrial fields. Throughout the ages it has been valuable for clothing and shelter, but modern minds carry its employment much further. Because of its structure, it is useful for cushioning, filtering, wicking, vibration-isolation, lubrication, sound-deadening, heat insulation, grinding and polishing, packaging, and other applications in other and more specialized fields.

Felt is now rendering service in thousands of recently discovered ways, ranging from tiny filters in hypodermic needles to washers in block busters and padding for Flying Fortresses and amphibious "Ducks." It becomes cushioning for gun-turret mounts, insulation against vibration in fighting planes and tanks, and gaskets for gas-masks. In desert fighting felt keeps fine sand out of airplane engines.

Definite but differing reasons have led to the selection of felt for canteen covers, pack saddles, and ammunition cases. It has kept millions of pairs of feet warm through the centuries, and still is doing the same job. Aviators' helmets are lined with felt and the Navy North Atlantic Patrol, Coast Guard, and other service branches use combination felt masks and helmets in inclement weather. Recently, United States Army research in arctic Alaska, as well as civilian experiment, revealed once more the meritorious properties of wool felt for keeping troops warm.

Many industrial uses for felt have resulted from recent experiments, as, for example, in the elimination of vibration in factory buildings and other structures. This does not mean merely prevention of damage to machines, walls, and floors; eliminating vibration and, hence, noise, improves workmanship, morale, and health of employees.

Because of its porous structure, felt can be made into consistencies which are effective for heat and sound insulation, and it reduces resonance by absorption when applied as a surfacing material, as in the lining of airplane fuselages and cabins. A blend with kapok fiber for such linings provides excellent thermacoustic properties.

Quite a different type of mechanical use for felt depends upon its capillarity. All sorts of motors—in electric fans, electric razors, and so on—are lubricated with felt wicks. Ink for automatic printing equipment is fed in this way, and numbering machines, postage meters, and telegraphic printing instruments use felt for the same reason.

Sealing of ball bearings against moisture and abrasives and preventing leakage in oil pistons, grease guns, universal drive-shaft housings, and various other

Courtesy U. S. Army Signal Corps

Para-ski troopers rolling ski-equipment bundle, lined with wool felt padding for protecting contents when the bundle is dropped from an equipment-carrying plane

Curtiss-Wright plane being lined with kapok felt for sound-proofing and thermal insulation

As familiarly known, wool felt is a springy, resilient substance, but it can be processed to almost any consistency from the softness of thistledown to a surprising degree of hardness. Unlike true textiles, in which spun and twisted fibers are guided into a predetermined pattern by weaving or knitting, the fibers in felt are "teased" into an almost self-selected arrangement, without distortion of their natural twists and bends.

In the highest grades of felt, clip wools and "noils"—the soft combings of the sheep's coat —such as those usually spun into yarn, are used. (Felt hats are often made of rabbit, beaver, and other furs, sometimes with a percentage of sheep's wool, depending upon the grade; but for industrial uses these furs are not employed to any extent, as they lack certain of the desirable qualities offered by wool.)

In the manufacture of felt, the interlocking of fibers is obtained, under controlled conditions of pressure, temperature, and moisture, by carding, hardening, and fulling so that they tangle into a three-dimensional fabric. The longer the pounding of the fulling process is continued, the more closely the fibers are compacted and the denser and stronger the product becomes. By repeating the fulling operation, felt may be rendered hard as a wooden board, a consistency used in wheels for polishing plate glass and searchlight lenses and in numerous metal-buffing operations. With less fulling, intermediate gradations may be obtained, having resilience, which is useful for cushioning; controlled porosity, the property needed in wicks and filters; and warmth, a function of porosity due to the inclusion of dead air.

A primary advantage of felt is that when cut in any direction, the edges will not ravel or fray. Consequently thousands of items, ranging from military insignia to corn plasters, are simply cut from the goods at a single stroke of a cutting die, and when so chopped out are ready for use. Mechanical felts, such as washers, oddly shaped gaskets, grommets, grooved channel, and round wicks from one-sixteenth of an inch to an inch in diameter, are in this way cut from roll felt to customers' blueprint specifications. The accuracy of these operations is remarkable con-

A Few of the Many Uses of Felt for Today and Tomorrow

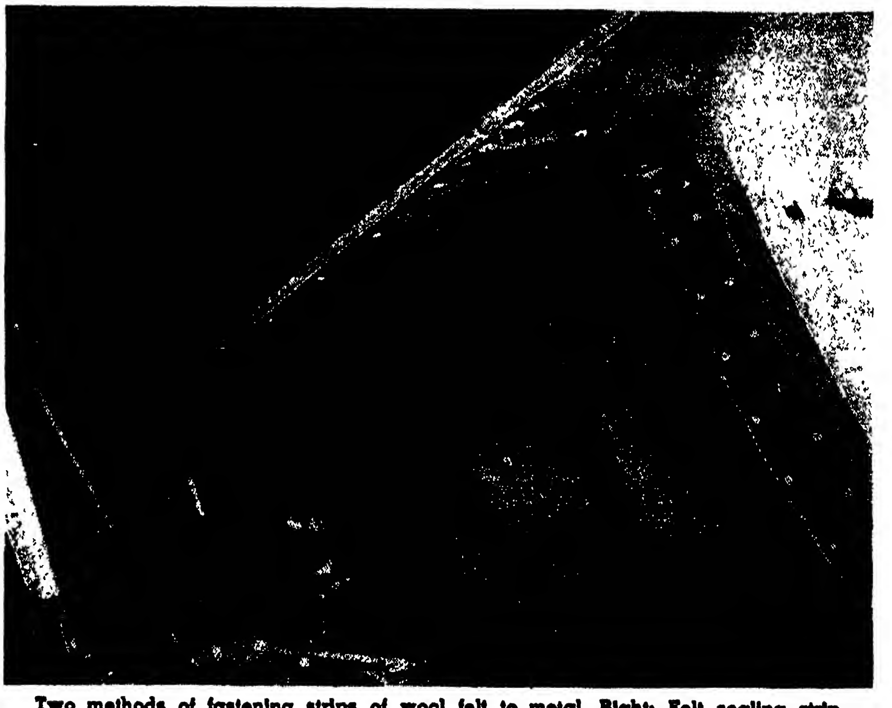
- Bomb sight cover padding
- Bulkhead insulation
- Fuel tank cradle padding
- Lubricating engines and motors
- Sensitive instrument mounts
- Thermacoustic cabin lining
- Signal Corps carrier bags
- Transmitter tube cases
- Arch supports
- Boots and shoes
- Caps
- Uniform linings
- Gas mask air filters
- Clutch housing and other dust covers
- Steering knuckle and other oil seals
- Motor car body-to-frame and other pads
- Artificial feet and hands
- Plaster cast padding
- Tourniquet pads
- Machine gun scabbard lining
- Thompson gun breech oiler
- Engine cylinder hones
- Eyeshields
- Vibration isolators

units is accomplished by the use of felt. Millions of bearings are literally sealed for life by felt washers backed with a layer of synthetic material. The felt forms an oil reservoir and distributor, due to its natural wicking properties, while the impervious backing acts as a dam to exclude grit and moisture.

Then, too, the fibers and interstices in certain grades of felt are so fine that they are useful in filtering liquids such as alcohol, gasoline, electroplating solutions, latex, and so on, in both gravity and pressure equipment. Non-reactive tendencies make it desirable for filtering fruit syrups. It has important surgical applications, too, as in blood transfusion apparatus, and finds wide use in respirators and industrial dust masks. It enjoys a high rating for removal of lead particles and other solid impurities in the air.

Another important virtue of felt is that it can be readily combined with certain natural and synthetic substances such as cotton, rayon, kapok, plastics, silk, jute, hair, and so on. Coating felt with a film of synthetic rubber proofs it against absorption of oil, water, and acids. Such rubber-coated felt pads often weigh only about one third as much as similar pads of molded rubber, an important factor in airplane construction. Impregnation and lamination of felt with plastics gives the desirable toughening qualities of felt to the combination.

There are two general classes of felt parts which are acceptable under government specifications as alternates for rubber parts. One is a felt part, identical in form and dimensions to the original, which has been impregnated with rubber or a rubber-like plastic material. The other is that in which the part has been coated, usually by a simple dipping operation. A third development along the same line leads to molded rubber parts having a felt core.



Two methods of fastening strips of wool felt to metal. Right: Felt sealing strip fastened by old method of riveting. Left: New Morrison metal stitcher method

Metal sticher efficiently and speedily stitching felt sealing ring to metal

sidering the nature of the material, as permissible tolerances are commonly expressed in thousandths of an inch.

An important fact in connection with the use of felt as an alternate for other engineering materials, is its comparative and often complete immunity from many influences which are detrimental to substances formerly employed. Sunlight, ozone, strong acids, and petroleum derivatives are destructive to most rubbers, for example, but do not injure felt because the wool of which it is composed is impervious to their influences.

Thus the multiple uses of felt derive from the inherent properties of sheep's wool and from the variety of consistencies to which it can be processed. Wool felt, therefore, is sometimes called *natural* felt, to distinguish it from felt-like products which are built up and bonded together by artificial means. Wool felt, by contrast, is composed exclusively of interwoven fibers, and when impregnated with another substance, the impregnation is for purposes other than binding.

Undoubtedly felt is going to play a part of growing importance in the new world of mechanical products in the post-war era. The chief reason is because it is chemically stable. Many products of chemical processing are subject to internal change, as time-tests and research reveals: some "age," as does rubber, whereas felt is different. It is a mechanical rather than a chemical combination, produced from natural fibers whose important element, keratin, was stabilized by Nature before the parental fleece was shorn. This substance is unaffected by manufacture and time has only slight effect upon it. Many relics from Egyptian tombs and other ancient caches bear witness that it lasts for ages.

• • •

Photography, An Industrial Tool

Sensitized Film is Being Applied to New and Important Uses, not Only in the Laboratory but for Constant Checking of Production. The Spectrograph, the X-Ray, Photomicrography, the Profilograph, and the Motion Picture All Find Applications

By ALLAN PERRY

E I du Pont de Nemours and Company, Inc

In significant and spectacular ways, photography is coming into its own in industry. Headlines have been accorded to such developments as million-volt X-ray radiographs, electron microscope pictures providing useful magnifications of 100,000 diameters or more, and the reproduction of "lofting" layouts printed on steel templates. Yet there are other new procedures, less publicized, which represent important uses of sensitized film as a tool of industrial research and production.

The spectograph, for example, is being utilized increasingly in the laboratories of the nation for making quick and accurate analyses of many substances. By means of this instrument the light given off by burning a specimen of the unknown material is passed through lenses and prisms and made to form a "picture" of the various wave-lengths emitted by the burning material. Thus a fine-line spectrogram is produced, characteristic of each chemical element. From this record the unknown material is analyzed in a matter of minutes compared with hours, if not days, required for ordinary chemical procedures. The minutest trace of an element, such as a metallic impurity too small to be analyzed by chemical means, is instantly revealed. And the information is definite and positive.

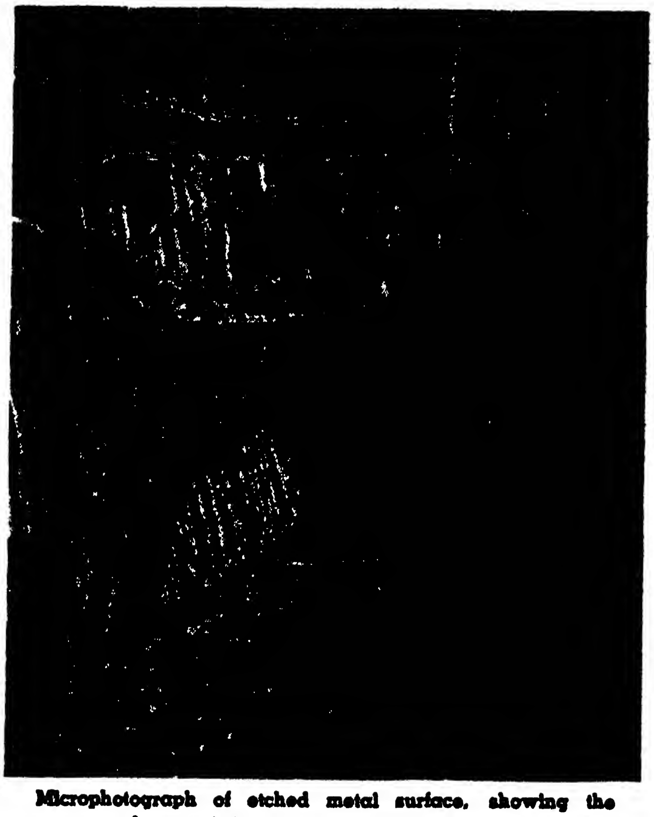
Although proper interpretation of spectrograms calls for a high degree of specialized academic training, many of the mechanical operations incident to making spectrographic pictures can be performed by a skilled technician who has little or no knowledge of the fundamental principles of spectroscopy. But all spectroscopic work calls for the utmost in orderliness and cleanliness, since contamination of the sample by even a slight trace of "dirt" might give rise to highly misleading results.

Operation of the spectrograph is simple. The specimen to be analyzed is placed in the cupped end of the lower of two vertical carbon electrodes. As the specimen is burned in the electric arc, its characteristic light passes through a prism and the prismatic "colors" are registered on photographic film, not, however, as colors, but as narrow lines or bands corresponding to wavelengths of the radiations emitted. Interpretation of the clusters of fine black vertical lines—each group representing one or more spectral colors, and, therefore, the presence of a particular element—is facilitated by comparison with a standard spectrum scale. The relative positions of the dozens—possibly hundreds—of black lines tells the qualitative story. At the same time density or "blackness" of the lines yields quantitative information, which, for rapid work, is accurate to plus or minus 10 percent. With more care, however, the margin of error can be held down to around 2 percent.

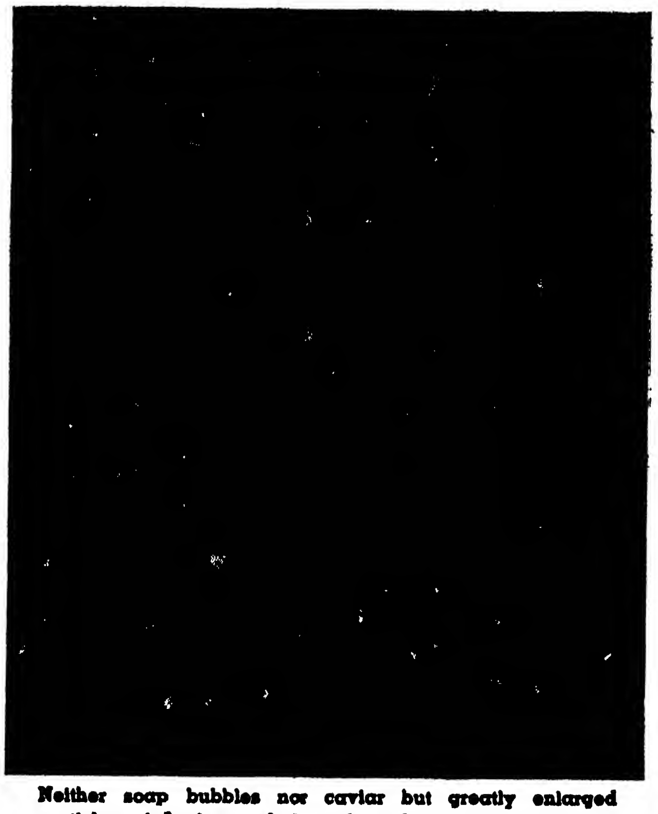
Shortly after a spectrograph was installed at the Du Pont Experimental Station, the instrument proved its worth with a typical performance. At that time new equipment was being installed in a nearby pigments plant. Workmen were lining certain reaction vessels with lead of a supposedly high degree of purity, which, however, was acting badly. It would not "weld" properly and, although the manufacturer of the lead insisted his product was of the required purity, its behavior indicated otherwise. A specimen was taken to the spectroscopic laboratory. Within 20 minutes it was found that the lead contained both tin and antimony in detrimental amounts, and it was the presence of these two unwanted metals which caused the trouble encountered by the "lead burners." Ordinary chemical analysis might have held up lining this essential equipment for days, and even then it is doubtful whether the chemist could have told the entire story, unless very large samples were used, since only small amounts of the contaminating metals were present.

Excellent for such detective jobs, only a short time later the spectrograph tracked down the source of traces of manganese contaminating a chemical product. Inadvertently, so it proved, a piece of welding rod of the wrong composition had been used in making the welded seam of a piece of plant equipment. This error—due probably to improper labeling of the welding rod—resulted in manganese contamination.

In the applications of X-rays to industry, the most familiar branch of the science is called radiography. Different materials absorb X-rays in varying degrees. As these rays penetrate, a



Microphotograph of etched metal surface, showing the pattern characteristic of a certain experimental alloy



Neither soap bubbles nor caviar but greatly enlarged particles of Lucite methyl methacrylate molding powder

"shadowgraph" is registered on film, showing the shadows of structural details or cracks and hollow spaces in welds and metal castings.

It is but a logical step to team up X-rays with magnification. Yet this step was taken with difficulty since there exist no lenses, comparable with the lenses of a microscope, for the enlargement of X-ray images. Micro-radiography must rely, therefore, on microscopic enlargement and photography of the image recorded in the developed silver emulsion of the original X-ray film. Relatively little attention has been paid to micro-radiography as a method for industrial testing and research, yet it has great inherent possibilities.

Enlargements up to 300 diameters without loss of detail are now being produced in research laboratories and in testing many important war materials, especially alloys. This new technique depends on an extremely fine-grain emulsion, together with the employment of radiations of two or more wavelengths. That is, the radiographer, using an ordinary diffraction X-ray apparatus, chooses certain wavelengths which will give suitable differentiation between the metals in any given alloy specimen. For example, certain bronzes have been successfully micro-radiographed using the characteristic radiations of molybdenum and copper.

The advantages of this technique are several. A three-dimensional view of a specimen is obtained, compared with a two-dimensional view obtained by ordinary photomicrography. An instance of the value of such an image is well illustrated by the revelation of an impurity in very large grains of silicon steel for heavy duty electrical use which was missed entirely on photomicrographs of the metal surface.

Another typical micro-radiograph shows copper in layers in an age-hardened aluminum alloy for aircraft when the copper, to give satisfactory performance of the alloy, should have been in solid solution. Still another application revealed cracks in cartridge brass resulting from improper seasoning or annealing operations—a long recognized and dreaded type of failure.

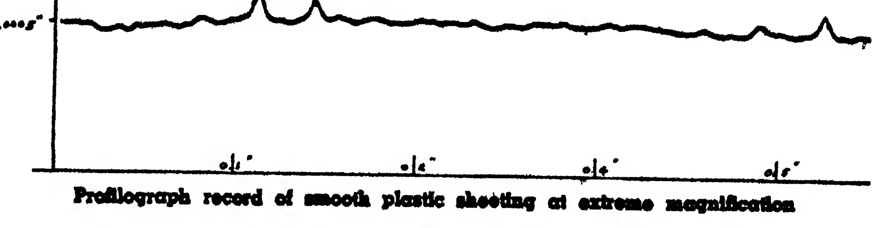
Prof. G. L. Clark, of the University of Illinois, who developed the technique involving the use of an ordinary X-ray diffraction tube instead of the very soft radiation used in earlier work, has demonstrated the value of micro-radiography not only in a wide variety of alloys but in many other materials. Metals such as tungsten, which are most difficult to use in photomicrography, lend themselves to this method. Ceramic materials, minerals, powders, fillers in rubber and plastics, bone structure—especially in the cases of lead poisoning—soil and clay sections, fillers in paper, and foreign particles in insulators all have been successfully subjected to this technique.

Sensitized film plays a part in a useful instrument known as the profilograph, a device capable of measuring the smoothness of surfaces. This machine is so sensitive that it can be made to record even sub-microscopic "roughness" of surface contours. A "profilogram" of a smooth plastic sheeting, for example, has the appearance of an outline of a mountain range.

Roughly, the profilograph comprises a vertical pinpoint with mirror attachment, under which the surface to be examined is moved slowly, in a lateral direction. A ray of light from a fixed source strikes the mirror attached to the pinpoint and is reflected to a distant scale, forming what is known as an "optical lever." As the surface under investigation is moved slowly under the pinpoint, which is free to rise and fall with surface irregularities, these variations are recorded by the light ray falling on film.

Visual education, with movies as textbooks, is being employed to great advantage in training our Army faster than ever before in history. Industry also is educating hordes of new workers to their production tasks with training films.

From the first day in camp for the raw recruit to the time he starts his schooling as a tank repairman, a bar-



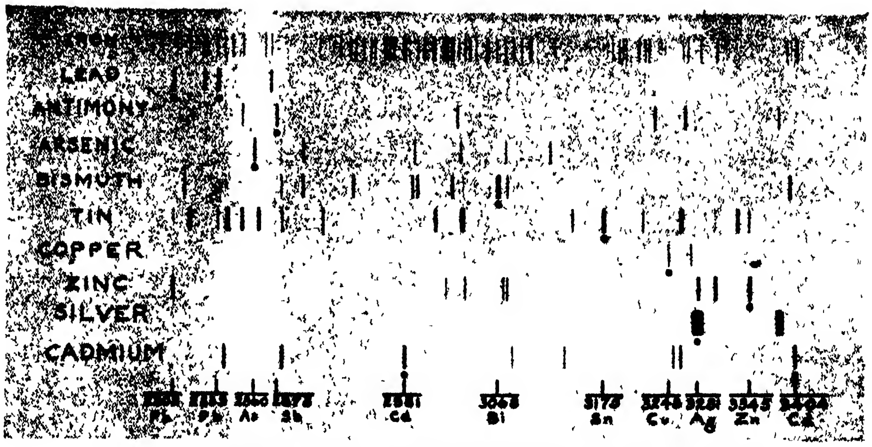
Profilograph record of smooth plastic sheeting at extreme magnification

rage balloon crew member, or just as a smart infantryman, he goes often to the movies to learn his job.

Prints by the hundred of each training film, as factual and accurate as Hollywood's are make-believe and glamorous, are sent to camps all over the nation, and to posts abroad from Iceland to Australia, where they are shown and reshown, studied and restudied. As much as 40 percent of training time has been saved when men see as well as hear their lessons.

Seeing is believing—and understanding. The Army knows that a recruit can be told over and over again the wisdom of digging a fox hole quickly and deep, that German bobby-traps call for extreme caution, but in combat excitement the soldier is prone to forget, especially the first time, which, unfortunately, may also be the last time. Therefore, experts are filmed showing not only what to do, but what happens through failure.

Looking ahead to the post-war world, it may be said that the wartime use of motion pictures in plants and among the services to teach will have far-reaching effects. Peacetime educators long since recognized that the written word is subject to the personal interpretation of the individual, and oral instruction likewise becomes adulterated, but the motion picture impresses the original form and meaning.



Everyday elements in the electric arc as seen by the spectograph

Numerous other examples of film as an industrial tool might be cited. More familiar procedures would include the X-raying of castings to detect flaws, also microcopying for the preservation, economical storage, and easy transportation of blueprints and documents. New is the method of making a photographic "plate" by sensitizing one surface of structural sheet metal with emulsion. Already in use in aircraft factories, this production time-saving process is put into play when a mechanical drawing, made on metal coated with a fluorescent lacquer, is exposed to X-rays placed in contact with the sensitized sheet. The result is a photograph of the drawing, having the same size as the original. Tedious re-drawing by hand as well as the possibility of human error is thus eliminated.

Truly photography has come of age; the day is at hand when sensitized film joins company with man's major inventions for producing things faster, cheaper, and better.

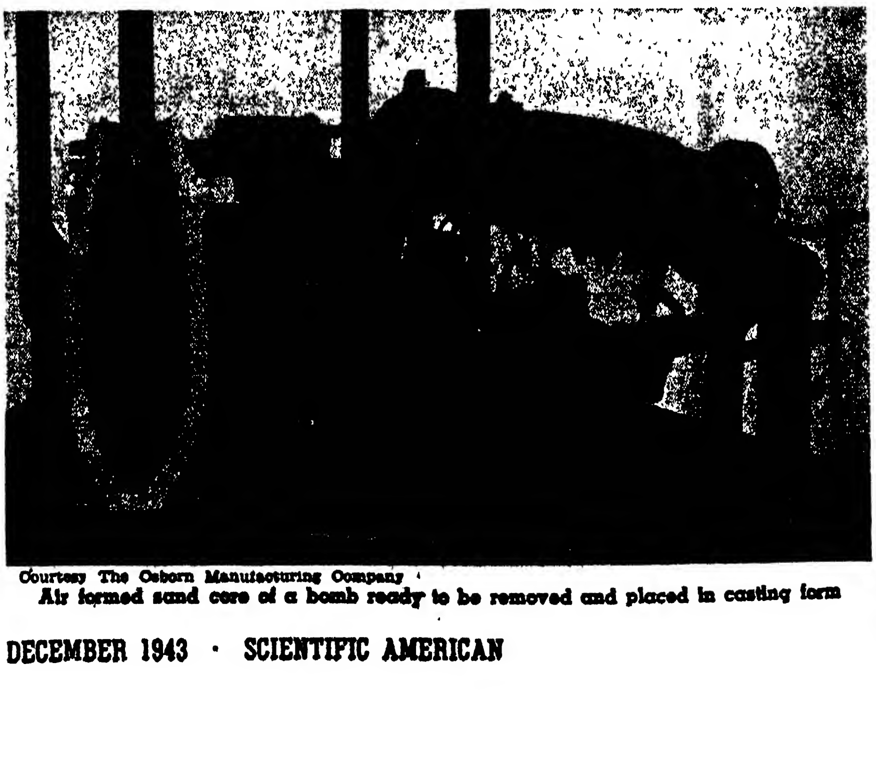
● ● ● ●

AIR-BLOWN CORES

Used in Foundries for Making Castings

HAND or mechanical ramming and tamping of sand to form foundry cores is being rapidly replaced by modern core-blowing machines which turn out cores of more accurate dimensions much faster and with far greater resistance to injury or damage during handling.

Cores to give desired inside dimensions and shapes in many products are absolutely necessary. Due to different shapes, contours, and the necessity for a solid outer surface, it would not be possible to drill or ream out inner cavities. Cores, therefore, of solid character must be a part of the casting pattern. These cores, due to the small opening of the completed casting, could not be removed after the casting is cooled if they were made of one solid piece. Thus sand is blown by compressed air into a core mold, and, because of dry binders, core oil, and moisture, this sand packs together in a smooth, comparatively hard-surfaced core. After the metal has been poured between this core and the outer mold and the casting cooled, the sand can be removed by pulverizing and used again after conditioning in another core.


Courtesy The Osborn Manufacturing Company
Air formed sand core of a bomb ready to be removed and placed in casting form

To produce satisfactory cores for this type of casting, compressed air must be supplied in adequate volumes, at constant pressure, and free from excessive moisture. The most commonly used blowing pressure for core molding is from 100 to 120 pounds at the machine. Small cores, on the other hand, are successfully blown at pressures as low as 90 pounds.

One of the dramatic applications of compressed air in war production foundries is found in the manufacture of aerial bombs. Cores for these bombs are made in quantities and in many different sizes by core blowing machines and air compressors.

CAPSULE-TABLET

Has Advantages in Administering Vitamins

VITAMIN preparations and concentrates can be administered with greater ease and efficiency in a new capsule-tablet used by Lederle Laboratories for its products of the kind.

The new dosage unit consists of an emulsion of the vitamins in gelatine, each unit being subsequently coated with a seamless, leakproof outer layer of plain gelatine. Important advantages lie in the fact that the oily vitamin mixture exists in tiny droplets firmly embedded in the gelatine mass and hence cannot escape, as it would through any

flaw in the gelatine coating of the usual capsule. Furthermore, the dose is released gradually as the gelatine dissolves and in infinitesimal droplets, the preferred form for assimilation. No large drop of oil is suddenly released, as with gelatine capsules hitherto used, to cause eructation and unpleasant aftertaste. The final protective coating of gelatine surrounding the particle of emulsion—thinner than that required to hold oil—is extremely slippery when moist and slides easily down the throat.

AIR-RAIL TERMINAL

Planned to Handle All Transportation Facilities in Mid-West

PLANS for a $25,000,000 mid-continent air freight and passenger terminal at Oklahoma City to provide coördinated post-war facilities for handling highway, rail, and air traffic at the geographical center of America's transcontinental airways were announced recently. The program, which is to be financed entirely by private and local funds, calls for a terminal layout covering six square miles, within nine miles of the city's business center, and a seaplane base on a 2500 acre lake.

Preliminary plans already completed by the Austin Company, designers and builders of the country's largest aircraft plants and airports here and abroad, call for the construction of two 11,000 foot runways, 500 feet wide, to serve glider tow-trains and planes carrying up to 400 passengers or 160,000 pounds of freight. Four other runways for commercial planes, a civilian flying field, a helicopter base, a passenger terminal with 100-room hotel, and hangers would complete the aviation facilities.

Railroads and truck lines will enter the terminal on a level below the apron devoted to loading cargo planes, for direct transfer of mail and freight between land and airborne transports by gravity conveyors and elevators. Private motorists and motor buses, as well as interurban transit lines, will have direct access to the passenger terminal through traffic arteries paralleling the rail and truck facilities.

DIESEL NOISE

Can be Abated by Correct Design

NOISE in Diesel engine exhausts is caused by longitudinal oscillation at acoustic velocities of gases which snap like a teamster's whip unless checked, while noise in Diesel blowers can be silenced by eliminating easy modes of vibration, according to Ralph L. Leadbetter, of Burgess Battery Company.

Mr. Leadbetter, addressing the Diesel Engine and Fuels and Lubricants Meeting of the Society of Automotive Engineers, warned that application of a braking effort to gas oscillation in the exhaust line may interfere with proper scavenging and recommended a "snubber" having a volume of approximately 40 times the volume of gas discharged into the exhaust pipe with each pulse from the engine.

Silencing the air intake was said to call for preventing noises due to vibration of housings and for quieting the air inlet opening, the scavenging pump, or the blower. Mr. Leadbetter suggested that the blower housing could be laminated as an expedient, but should be constructed either in sections or with ribs cast integral with the surfaces, to prevent ringing.

COLOR MATCHING

Camouflage Work Aided By Electronic Device

A VITAL role in helping our fighting forces to deceive enemy observers is being played by General Electric's recording spectrophotometer, which is described on page 256 of this issue. The instrument is being used to match camouflage colors so that they cannot be detected by the enemy's infra-red cameras.

Camouflaging, an art which depends on the use of color, suffered a major setback when the infra-red camera was developed. Infra-red light, which is not visible to the human eye, can be photographed on special film. Thus, two objects which to the eye have the same color may photograph differently with the special film, due to different amounts of infra-red received from them. This means that the camouflage artist cannot judge from the appearance of a color how it will look to the infra-red camera.

But the spectrophotometer, an electronic machine, has now come to the aid of the camouflager. It gives him a measure of color—both visible and invisible—which puts him on an equal footing with the infra-red camera. For by determining the amount of light on infra-red wavelengths that is reflected by any paint or other material he wants to use, he can tell what effect that material or color will have on the plate of the infra-red camera.

COMPRESSORS FOR EXPLOSIVES

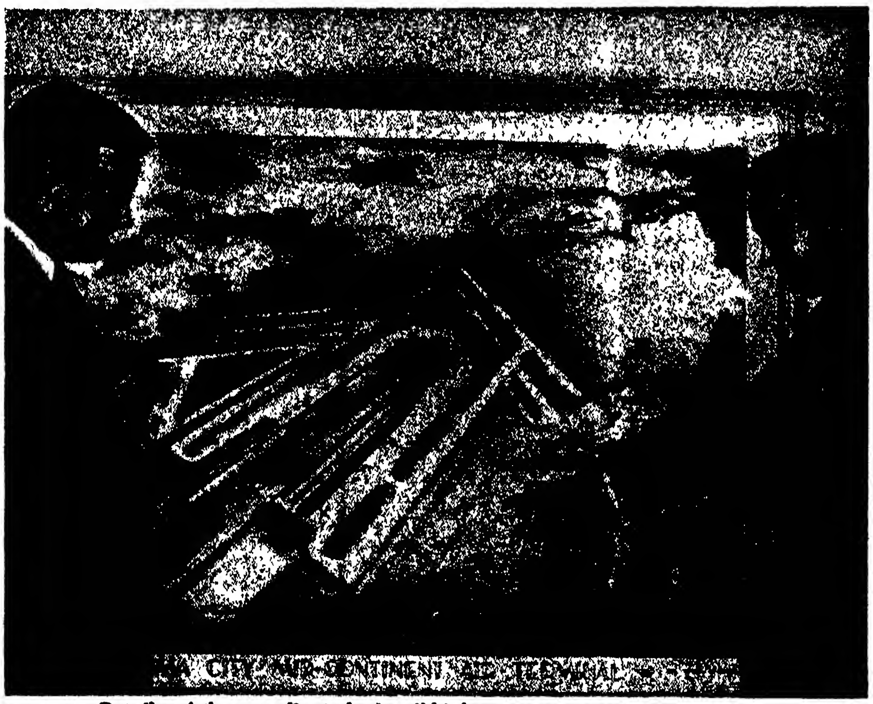
Production of Nitric Acid Requires High Pressures

AIR COMPRESSORS are vital in the manufacture of explosives, being used in many of the involved steps in the production of nitric acid, obtained from synthetic ammonia.

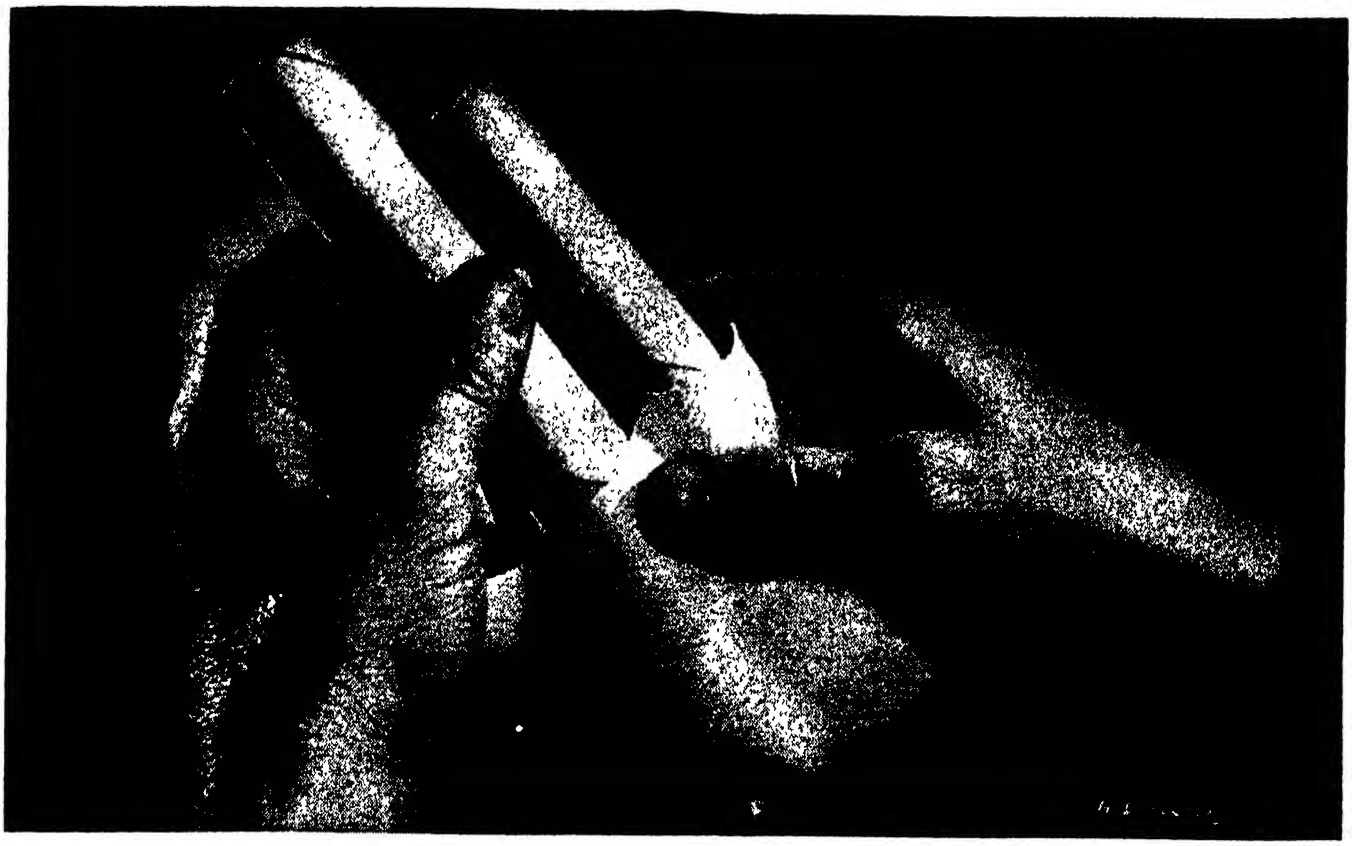
In the process of nitrogen fixation, it is necessary first to obtain a supply of various gases in their free state. This is normally accomplished by burning natural gas in a reducing atmosphere or from a coke-gas plant. The raw gas that is obtained from these plants normally consists of nitrogen, hydrogen, carbon-dioxide, carbon-monoxide, and certain other small impurities. It is necessary to remove all components except the nitrogen and hydrogen from this mixture so that these two gases can be combined synthetically into anhydrous ammonia for fixation of the nitrogen.

The carbon-dioxide is normally removed under a pressure of approximately 200 pounds per square inch by means of scrubbing the gas through a water tower, with the carbon-dioxide being absorbed in the water in a dissolved state. The carbon-monoxide is removed from the gas in a second scrubbing tower under a pressure of approximately 2000 pounds per square inch by the use of an ammoniacal cuprous copper formate solution. After these gases have been removed the remaining product, consisting of nitrogen and hydrogen, is then compressed to a pressure of approximately 5200 pounds at which pressure it is exposed to a catalyst and, through the addition of heat, a chemical combination takes place resulting in synthetic gaseous ammonia which is then condensed by refrigeration to an anhydrous ammonia state.

Only a portion of the gas passing through the catalyst is actually con-



Details of the coordinated air-rail-highway terminal described above



A large electric-driven air compressor of the type used in powder factories

verted to synthetic ammonia. It is necessary, therefore, to install special high-pressure circulating compressors to take the uncombined gases from the system after passing through the catalyst and for recompressing to a pressure equivalent to that of the raw gas being pumped to the catalyst chamber.

A normal present-day synthetic ammonia installation is designed for the production of 300 tons of synthetic ammonia per day and involves approximately 22,000 horsepower of high-pressure compressors and circulators. In addition, approximately 5000 horsepower of compressor capacity is required to furnish the necessary refrigeration for regenerating the solution used in the removal of the carbon-monoxide as well as for other steps in the process.

An additional amount of low-pressure air at approximately 50 pounds pressure is used in the regeneration and stabilization of the solution for the removal of the carbon-monoxide.

Synthetic ammonia is then applied to the manufacture of nitric acid bv burning the ammonia gas with air, the by-product being dissolved in water for the manufacture of nitric acid. Nitric acid is normally made at a pressure of approximately 50 pounds per square inch. This acid can then be used for manufacturing TNT, ammonia picrate, or many of the other explosives—*Data from The Compressed Air Institute.*

WORKERS' EYES

Are Receiving Increasing Attention In Industry

INCREASING attention to the visual qualifications of employes is reported in many manufacturing industries, according to the Better Vision Institute. Not only do many plants require workers to tune up their eyes when necessary, but steps are taken to coördinate eyes and jobs.

One New England plant engaged in war production requires tests to determine how the eyes will function on the job. Besides being examined for visual acuity, eyes of some workers are studied to see if they see design lines accurately, and if they see dimensional lines of machines and parts in correct proportions. Such visual qualifications may have an important bearing not only upon accuracy of workmanship, but also safety. Other workers are tested for their visual ability to identify metals and alloys from appearance. Skilled metal workers frequently are able to determine properties of a metal from visual inspection.

ANIMAL BLOOD

May be Made Available For Human Transfusions

EFFORTS to render blood of animals suitable for human transfusions are being made by Professors Frank W. Putnam and Hans Neurath, of Duke University, according to a paper read before the American Chemical Society recently. In the paper it was pointed out that protein molecules have a coiled structure which can be loosened or tightened by suitable manipulation with certain organic substances such as urea to modify their chemical nature and hence their disease-curing effects.

It has been discovered by Drs. Neurath and Putnam, in experiments on animals, that various proteins, including blood serums, lose their shock-causing properties after such treatment.

Investigation has shown that synthetic soaps are most effective in modifying the chemical nature of these proteins. Experiments are under way to learn whether they may serve as a means of treating blood proteins to avoid the serum-sickness that is always a risk in immunizing sensitive persons against certain diseases.

These experiments, conducted in laboratories at Duke, are part of the more general problem of investigating factors which cause proteins to produce anti-bodies when injected into human beings for therapeutic purposes.

STEEL HIGHWAY

Experimental Strip Uses Interlocked Grid

THE POSSIBILITY that American motorists may be zipping over steel highways soon after the war loom as a result of an experimental installation of a steel roadway strip on a Connecticut highway. The installation, while only 48 feet long and 22 feet wide, is expected to provide the answer to the practicability of entire roads based on a steel grid.

The experimental project is a joint venture by the town of Darien and the Irving Subway Grating Company, creator of the steel-type roadway. This "armoring" of highways is an off-shoot

Applying oil to the steel-grating highway test strip

of the technique employed at battlefronts in laying down landing mats for the air forces.

The Irving Company has experimented with and developed for 30 years various types of steel floor surfacing applied to factories, power plants, and bridges. More recently, at a Long Island City testing grounds, Irving engineers have experimented with steel surfacing of truck roadways in and about roadway plants. In these experiments such roadways have proved durable and quickly and easily laid.

Sponsors of the highway project feel that it is highly significant—that if it proves successful, it may well set the pattern for a network of steel secondary roads throughout North and South America. The technique calls for interlocking steel grating panels, each 2 feet by 12½ feet; filling the mesh with ordinary construction sand; and then applying a coating of road oil.

COPPER SAVER

Used in Electroplating Baths To Increase Hardness

Less than one ounce of a new chemical per gallon of copper electroplating solution reduces by one third the copper required for electrotype printing plates, and cuts in half the scrap resulting from manufacture of these plates. The chemical so increases the hardness of the copper deposit that a much thinner layer will give equal service. It allows a pound of copper to cover one third more square inches of surface; it also assures a smooth finish, and speeds the plating of the electrotypes.

The agent, recently announced by Du Pont, eliminates inferior plating on the edges and corners of the printing plates. That permits a reduction in the width of "safety bearers," and accounts for reducing to half the copper scrap usually resulting from electrotype production.

KOVAR SUPPLY

Problem Solved by Miniature Furnace

A thermometer manufacturer now producing temperature gages for military aircraft was threatened with a stoppage of production of these essential accessories due to the need for "Kovar" wire. Kovar, a nickel-cobalt-iron alloy, was developed by Westinghouse Electric and Manufacturing Company as a sealer for electronic tubes. In these gages, however, it is used in the form of a three-foot length of fine wire, tightly coiled inside a tube immersed in the aircraft engine oil. As the motor warms up the wire offers more resistance to an electric current passed through it, which is indicated by a dial on the instrument board.

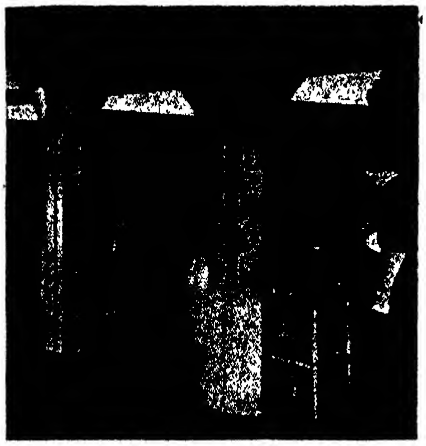
In ordinary production quantities, and for the more common uses, the electrical resistance of the metal is not important, but to the temperaure gage manufacturer, it is vital. As war demands depleted his original supply of Kovar wire, he found that the resistance of additional samples varied widely, and continued production was threatened because the thermometer design was based on the resistance of the old wire and there was no time to re-design the entire device.

The problem was solved by the Westinghouse Laboratories' use of a miniature electric furnace to produce 13-pound ingots of Kovar made to the exact chemical composition of the original product by painstakingly accurate control of the melting process. Actually, a half dozen of these small ingots of proper resistance will keep the thermometer plant supplied with wire enough to last several years, since each ingot contains enough Kovar to make 56 miles of wire, which is enough to make temperature gages for 20,000 four-motored bombers. Yet continued inability to obtain this small quantity of vital metal in the exact quality required, might have caused a serious hold-up in quantity production of these and other military craft upon which final Allied victory depends.—*Nickel Steel Topics.*

SAFETY BOOTHS

Contribute Also to Worker Comfort

Specially designed booths, perfected over a period of years for the safety and comfort of workers handling difficult and dangerous propeller finishing operations, have now been installed in



Individual safety booths

New Jersey plants of the Propeller Division of Curtiss-Wright Corporation. The individual safety booths, arranged in series with one operator to each unit, are air conditioned to carry off harmful dust particles, lessen workers' fatigue by cutting down noisy grinding operations, and practically eliminate hazards created by flying pieces of metal.

The units, installed exclusively for grinding and polishing operations on hollow steel blades, are built of Thermax, which is a non-priority, non-combustible material. Each booth is clean, comfortable, and lighted by two 80-watt fluorescent lamps designed to reduce eye strain. A fan unit is installed at the rear of each booth to carry off dust and small metal particles while larger pieces of steel are thrown into a salvage hopper below. Passing workers are protected from flying particles by a baffle extending six inches from the interior of each booth.

Propeller Division officials claim the new safety booths have decreased the loss of man-hours through accidents and resulted in a speed-up in the production of blades.

ARC-WELDING SPEEDED

Use of High-Voltage Spark Maintains the Arc

A high-voltage "trail blazer" that cuts an electric path through air has been developed to speed welding of the thin aluminum and alloy steels used in warplane construction. Called an "arc stabilizer," the new device is an assembly of coils, condensers, and transformers built into an electric welding machine.

"The stabilizer," explains C. L. Denault, engineer at the Sharon plant of Westinghouse, "produces electricity which has a high voltage, or electrical pressure, and changes its direction of flow many thousands of times a second. This type of electricity has the ability to leap through the air from the tip of the welding rod to the metal being welded. It literally knocks electrons off the atoms of gas in the air. When the air is in this condition, it conducts electricity more easily. Then the regular welding current jumps from the rod to the metal along the path created by the trail blazer."

Until the stabilizer was developed, electric welding of plane parts required great skill. Low currents had to be used to prevent burning of the thin metals and this made it difficult for the welding operator to start the electric arc and keep it glowing while he made the weld.

When a welder is working on ordinary carbon steel, he has little trouble maintaining an arc because the current flows strongly, the metal is hot and the welding rod may be as thick as a pencil. But aircraft welding must be done with low currents, the piece being welded must be kept comparatively cold so no holes will be burned in it, and the rods used are often as thin as a pipe-cleaner. The arc itself is about the same size as the head of a safety match.

Under these conditions, the arc tends to go out each time the regular welding current alternated or changed its direction of flow, but this tendency can now be counteracted by the trail-blazing electricity which is turned on by a switch in the holder that grips the welding rod. When the operator is ready to weld, he flicks on the switch and holds the tip of the rod near his work. The high voltage electricity leaps across the gap and the welding current follows. The "trail-blazing" current keeps flowing until the weld is finished to prevent the welding arc from being extinguished.

Laboratory model of arc stabilizer

COLORS FOR SAFETY

Yellow Often Better Than Red

Red is traditional in safety practice as a symbol of danger. Yet while it is a rich and exciting hue, it falls short of other colors where high visibility is concerned.

According to the Color Research Laboratory of the Eagle Printing Ink Company, the most conspicuous and visible of hues is yellow. Next in order is a brilliant yellow-green. Following this, orange ranks third, with red fourth on the list.

In industry, for example in a steel mill or a printing plant, a good safety practice would suggest the use of yellow to mark moving parts, trucks, pillars, and the like. Yellow-green and orange might be used for other and perhaps lesser hazards—with red reserved for fire-protective equipment. Many factories have developed specific codes of their own, using the magic of color to serve as silent but effective tokens of identity and danger.

Yellow and yellow-green are the regions of highest visibility in the spectrum. In the dim light encountered in so many industrial environments, they are the two colors that hold their brightness best, with red fading out and resembling black—a phenomenon long recognized by science.

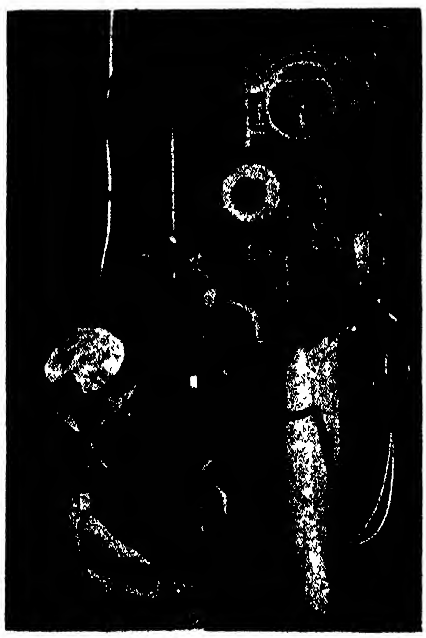
DETONATOR ASSEMBLY

Speeded by New Automatic Machine

A machine that does the work of approximately 75 workers, has been developed by engineers of Aluminum Seal Company for use in government arsenals. Called a foil disk assembly machine, the unit is employed on loading lines for seating foil disks in detonator cups.

Previous to the development of this machine, disk seating was accomplished by laborious hand methods. The tiny foil disks, which measure less than a quarter of an inch in diameter, were gaged by a micrometer to insure the seating of only one disk to a cup, then placed by means of hand tweezers in the cups.

In the new machine the detonator cups are placed in the hopper at the top, from where they pass automatically into a feed chute and from there to a transfer punch which transfers the cups, five at a time, into a seating block on an intermittent turret wheel. The turret carries the cups to a die which blanks out the foil disks and pushes them to the bottom of the cups. The foil used for these disks is coated on one side with a thermoplastic adhesive and is fed automatically through the die. A vacuum shoe under the seating block insures retention of the disks and permits



Detonator assemblies machine

the punch to return to its original position without the disk.

Further revolution of the turret takes the detonators to a hot punch station which heat-seals the disks to the bottom of the cups.

After seating, the detonator cups pass to the next station where they are released and drop by gravity to an automatic inspection unit. At this point the cups are pulled out of the inspection turret by vacuum to drop into a bin at the bottom of the machine. In the event that the disks are not properly seated, they are not ejected by the vacuum plunger but are carried around in the turret to drop into a reject box.

Besides materially speeding up seating operations, the new machine eliminates one of the chief hazards which formerly accompanied the loading. Heat sealing by machine insures perfect adherence of the disk to the cup and does not permit the powder to seep underneath the disk. Results obtained to date indicate a marked decrease in the number of cups rejected for this reason.

ROTENONE INDUSTRY

Expected to Expand in the Western Hemisphere

ELEVEN of the other American republics are co-operating with the United States in a program to expand Western Hemisphere production of rotenone-yielding plants to meet increased wartime demand for this insecticide, now in wide demand for production of food crops.

Before Pearl Harbor, cultivation of rotenone-bearing plants was increasing rapidly in the Far East, and the United States obtained nearly half its supply from that source, although one of the two principal rotenone plants is native to this hemisphere.

Wartime development is giving the plantation industry the strongest impetus yet experienced in the Americas. Out of this development, some agriculturists believe, may come a lasting industry to supply the big Western Hemisphere market for insecticides.

Peru now is the principal exporter of rotenone roots to the United States. Another large exporter is Brazil. Wild roots are being gathered in Ecuador, Colombia, and Venezuela. Development programs have been started in Ecuador, Mexico, Guatemala, Costa Rica, Honduras, El Salvador, and Haiti.

Development plans call for the planting of about 1,000,000 additional cuttings of derris, one of the two chief rotenone-yielding crops.

The full effect of the rotenone development program in Latin America will not be felt until 1945. It takes two years or so for the crops to become ready for harvest. By 1945, however, bumper exports are expected.

In line with the policy of fostering complementary agriculture in the Americas, United States agencies are rendering assistance to the development of rotenone-yielding crops in Latin America. Derris cuttings by the thousands are being distributed from the United States agricultural station in Puerto Rico by the Office of Economic Warfare to plantations and to new experiment stations set up with the United States' assistance in Ecuador, Peru, Nicaragua, and El Salvador.

The newly-established Inter-American Institute of Agricultural Sciences in Costa Rica also is taking a hand in the development of insecticides. The Institute has acquired a rubber plantation in Panama which has a large supply of derris cuttings for distribution to potential planters.

Heretofore, rotenone-bearing materials from Latin America have been obtained mainly from wild and semi-wild growths. The chief Brazilian centers of production have been from semi-wild growths along the Xingu and Tapajoz Rivers and in the upper Amazon region. Now, in the Amazon as elsewhere in the hemisphere, new plantation industries are getting under way.

GOVERNOR TESTER

Is Accurate To Within Two Tenths of One Percent

AN ELECTRONICALLY-CONTROLLED precision testing apparatus that checks the accuracy of delicately balanced hydromatic airplane propeller governors, which are being manufactured for the Army Air Forces, has been developed by the Nash-Kelvinator Corporation.

When the company received a contract to produce these Hamilton Standard governors for propellers, it was found that none of the commercial test-

Timing aircraft propeller governors

ing devices available were sufficiently accurate to provide the test demanded by the specifications. The governor, which automatically adjusts the pitch of the propeller blades so as to make the most efficient use of the engine's power at a given speed, must be accurate to within five revolutions per minute, or two tenths of one percent at maximum speed. This was about four times as fine a "tolerance" as the efficiency of the best tachometer, or speed indicator, which could be obtained.

While the operation of the new testing instrument is difficult to describe, its principle is not complicated. The propeller governor to be tested is mounted on the stand and hooked up to an electronically controlled D.C. electric motor operated from an A.C. power line. The governor is then attached to a pressure oil system which serves as a "dummy propeller." Since the governor itself functions hydraulically it regulates the pressure in the testing device, and thereby actually regulates the speed of the motor by which the governor itself is being operated. But because of the wizardry of the test stand, this same motor, which both drives and is controlled by the governor, also drives an alternating-current electric generator. By measuring the output of this generator in cycles, the person testing the propeller control governor can tell far more precisely how accurate the governor is than he could by using the finest tachometer such as is contained on the control panel of an airplane.

What the amazing device does is to convert time, oil pressure, and revolutions per minute into one set of comparable figures which can be read off on dials as readily as telling the time of day by looking at a clock.

OPTICAL PARTS

Made More Accurately With Air Conditioning

ACCURATE gun fire of America's fighting ships and American artillery are due in a large measure to the utilization of modern air-conditioning equipment in the plant of Bausch & Lomb, where there was recently completed the third installation of air-conditioning equipment in the binocular assembly room of the optical manufacturer. Air-conditioned rooms are required for the preparation of optical parts of binoculars because dirt cuts the light gathering properties of the prisms and lenses. In cementing the lens elements, the room air must be scrupulously clean in order that the Canada balsam shall not be contaminated. Also, the temperature must be held within close limits both for applying the balsam and for drying.

Carrier air conditioning is also being called upon at Bausch & Lomb to aid in high precision work in the manufacture of range finders and height finders, essential components of modern warfare. In space where these products are manufactured, assembled, and tested, Carrier equipment reduces heat that is generated by motors and people, eliminating danger of expansion or contraction of delicate metal parts by maintaining constant temperature. Likewise, it controls humidity to prevent corrosion caused by perspiration on the fingers of workmen.

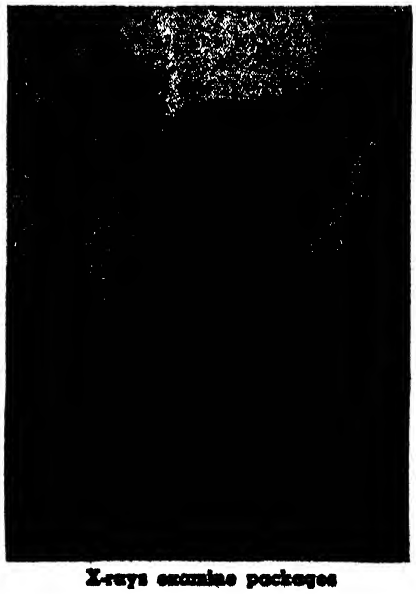
In the assembly of lenses in microscopes, air conditioning is used to dehumidify the air between the assembled lenses so that they will not fog up under the varying temperature conditions of field use. Absolute dust control is required because a speck of dust on a range finder, for example, might look like a distant airplane to the observer.

Polishing lenses is another delicate operation which calls upon air conditioning to help insure perfection. For the polishing process, lenses are mounted on wax and any change in the wax, either softening or hardening, might cause inaccuracies. Consequently, it is important that the wax mountings remain the same during polishing, and air conditioning insures against the possibility of changes.

SIMPLE X-RAY

Compact Unit Used for Examining Parcels

A NEW anti-sabotage weapon in the form of an effective, simple, easily operated X-ray apparatus is known as Searchray. This newly developed electronic device makes possible the safe, instantaneous, non-destructive, fluoroscopic, and radiographic internal examination of incoming and outgoing packages and small luggage at war plants, air and railway express offices, post offices, custom houses, police stations, and so on. Suspicious looking packages and luggage can be searchrayed without exposing anyone to the danger of opening unknown parcels. It is also useful in discovering contraband and in detecting and discouraging theft.



X-rays examine packages

To operate the unit, manufactured by North American Philips Company, Inc., it is only necessary to plug into a standard 110 volt A.C. power source, open compartment door, insert object, close door, push button, and view the internal structure instantly through an eye-level eyepiece. No skill is required to operate.

The same unit also has wide application in industry for internal examination of assemblies and finished products of rubber, ceramics, plastics, light metal alloys, and similar substances.

COLD WELDING

Makes Cracked Cylinders, Heads, Parts, Strong as New

WARTIME technique of cold welding, which repairs heat and cold cracks in gasoline, Diesel, steam, and other engines as easily as a dentist fills a tooth, is keeping in operation many an engine which otherwise would have been junked.

The technique, originally known as "mechanical lacing," is described in the *SAE Journal* in a report of the Society of Automotive Engineers Transportation and Maintenance Activity approved by Office of Defense Transportation.

The crack, wherever located, and whether caused by heat or cold, is drilled and tapped. Special threaded rods are inserted so as to interlock. The crack then is filled with a special sealing compound, which is also circulated through the cooling system. Finally, the repair is peened and smoothed to a point where it is practically indistinguishable.

The report states that so far as records are available there is no case of a repair failing as a result of time or mileage, and that, apparently, the repair lasts as long as the engine.

PAINT TESTING

Speeded By Use of Thin Iron Foil

THROUGH the use of a new testing technique which employs extremely thin iron foil, an indication of the value of metal-protective finishes under severe conditions frequently encountered in practice can now be had in a matter of days in comparison with months for ordinary exposure tests.

This new technique was described in a paper by Drs. G. D. Patterson and C. K. Sloan of the Du Pont Company, presented before the American Chemical Society. It involves the use of thin, uniform films of paint applied to small sheets of iron foil about one two-thousandths of an inch thick—approxi-

mately 1/8th the thickness of the paper on which this is printed. The film of finish to be tested is about one thousandth of an inch in thickness.

These tiny test panels are then exposed to a carefully controlled, humid atmosphere in the laboratory, which results in rapid rusting of the metal foil underneath the thin paint film in much the same way that painted structural steel would ultimately rust under actual conditions of service. The time that elapses before visible rust spots develop on the iron foil gives an indication of the degree of protection afforded by the paint being tested.

With such extremely thin foils, the slightest rusting eats a hole through the metal, which can easily be detected by looking at the test panel from the back. With ordinary films laid down on steel panels of the type normally used for testing, no evidence of failure would probably appear until rather severe corrosion of the metal had resulted in partial or complete breakdown of the paint film. With a good finish, this might require a year or more.

While the recently-devised technique will not dispense with long-time fence and field tests necessary to determine the protection a finish will afford under actual service conditions, it will greatly facilitate testing by making it possible to reject inherently poor finishes before expensive and time-consuming field tests have been made.

VITAMIN MANUFACTURE

The Human System's Processes Influence Manufactured Foods

THE MYSTERIOUS process by which certain vitamins are manufactured in the intestinal tract holds the key to great advances in the field of nutrition, Dr. Conrad Arnold Elvehjem, professor of chemistry in the University of Wisconsin, declared recently in an address before the Chicago Section of the American Chemical Society.

"We are spending a great deal of time measuring the changes in the vitamin content of food during storage, processing, and dehydration," Dr. Elvehjem pointed out, "but what about the changes that take place after the food enters the intestinal tract?

"All the food we eat comes in contact with trillions of bacteria, particularly in the intestinal tract, before the nutrients contained in that food reach our bloodstreams. The intestinal bacteria have caused us much trouble in the laboratory and will continue to trouble the clinicians for some time, because their effects are different for each species of animal and every type of food combination.

"Some vitamin factors are known to be produced by the intestinal bacteria under normal conditions, but certain individuals may suffer from abnormalities which are sufficient to prevent adequate production, and must have these factors preformed in the diet. In still other cases, abnormal intestinal flora may destroy some of the better-known vitamins at a rate sufficiently rapid to produce nutritional deficiency in spite of the fact that the diet is adequate according to present standards.

"Thus if we were to attempt to formulate a mathematical equation for the relation of nutrition to health similar to the equations formulated by Willard Gibbs in physical chemistry, we would need to introduce a constant to cover the effect of the intestinal flora. We would have to consider the kind of carbohydrate, the level of fat and protein, the ratio of many of the vitamins, the length of the large and the small intestine, the amount of bile secreted, the rate of digestion, the alkalinity and acidity of the intestinal tract, and the natural capacity to inhibit the growth of certain bacteria.

"It is remarkable that progress in the field of nutrition has been as rapid as it has under such variable conditions. In one of the first papers on vitamins, published in 1911, some of these difficulties were suggested."

The older B vitamins — B_1, B_2, and niacin — were recognized first because they are not produced in the intestinal tract of any animal in sufficient quantites to meet the needs of the animal, it was explained, thus making the testing of requirements by withholding certain factors from the diet comparatively simple.

The chief method of altering the intestinal flora is by feeding a bacteriostatic agent, for example one of the sulfa drugs, which inhibits the further growth of intestinal bacteria through

interfering with the supply of the B vitamins needed for bacterial growth. Inhibition of the growth of the bacteria prevents, in turn, the synthesis of other members of the B complex by the bacteria and permits the biochemist to measure the vitamin requirements of the animal by adding synthetic vitamins to the diet, according to Dr. Elvehjem.

NON-SLIP DECKS

Provided by Garnets

Embedded in Plastic

Bluejackets of the United States Navy, manning the thundering guns of battleships and cruisers as they hurl their exploding shells into the Nazi-held shores or the Japanese-occupied islands of the Pacific, take their stand on carpets of semi-precious stones. Naval planes, zooming from the flight decks of carriers with their deadly load of bombs and torpedoes, take off from runways of the same sort.

Garnets are being used by the Navy today to cover decks and gun emplacements of our ships, the gems, pulverized into coarse grains, forming part of a new deck covering manufactured for the Navy by The Goodyear Tire and Rubber Company.

The new covering, known as "Dektred," is made by mixing the ground garnets with a special fire-resistant plastic or synthetic-resin binder that has the ability to stick to the smooth steel surface of a battleship deck or similar structure. Dektred can be applied with a trowel or, more quickly, by spraying it from an ordinary spray gun.

The chief purpose of Dektred is simple, but as extremely important as it is simple. It is to prevent slipping, a problem that is of the utmost seriousness in naval operations. Slippery decks can cause accidents, even death. They can lose battles. The problem is particularly acute in rough weather or on small ships whose low decks are normally washed by the waves at high speeds.

Dektred is light-weight and can be shipped as a viscous fluid in sealed metal containers, ready for application. It can be applied to steel, wood, concrete, and many other types of surfaces. It dries quickly, being sufficiently dry for light traffic after 2½ to 3 hours and completely dry after 8 hours. It is resistant to both heat and cold. Cold does not affect it at all. It becomes slightly soft at temperatures above 160 degrees, Fahrenheit, but returns to its normal conditions when cooled. In addition, it resists the corrosive action of oil, grease, salt, sulfur, soap, and other detergents.

VISIBLE STRAIN

Aids in Studying

Response of Liquids

The diverse responses of a flowing fluid to variously shaped obstacles such as a boat hull or a heating pipe form a fascinating study, but not a very exact one unless the directions of flow can

be made visible. A new method of doing this, developed at the Massachusetts Institute of Technology, promises a real advance in this branch of hydrodynamics. The method is analogous to that wherein engineers use polarized light, produced with optical equipment similar to that in "Polaroid" non-glare sun glasses, to render visible the strains in plastic models of solid structures, such as gears. When stressed, the plastic model deforms slightly, and, in so doing, bends and twists the polarized light passing through it so that bands and splotches of color show up at the points of strain. In the analysis of fluid flow a suspension of bentonite (a clay found abundantly in the West) in the fluid serves to modify the polarized light shining through the transparent walls of the experimental channel, just as the plastic modifies light in analysis of strains in solids.

The bentonite particles consist of platelets so small that there is no tendency to settle out of the suspension and so light that they move exactly where the fluid takes them, showing substantially no inertia of their own. These physical factors, as well as its optical properties, make bentonite superior to other substances used to follow fluid flow, such as ink streams, smoke trails in gases, or fine bubbles; for these latter materials cannot follow the paths of fine eddy motion encountered when streamline flow is broken up. The bentonite for the first time permits quantitative measurement of velocity change and other factors within the field.

Solid plastic models examined with polarized light show infinitely varied colored patterns when subjected to pressure or tension. A line of a given color connects points where the strain is equal; from this the analyst can determine where the strains are concentrated and the model can be re-designed to put strength where it is needed and eliminate it where it is not needed. Similarly, in analysis of fluids the bentonite so modifies the light passing through the stream that colored bands or "fringes" show up, connecting points where a particular rate of change in the speed of the fluid prevails. Use of improved photographic techniques, including high-speed photography, has enabled observation of highly turbulent as well as more nearly streamline flow by this method.

The method can be used either qualitatively to observe how a moving or stationary object of particular shape affects the flow, or quantitatively to calculate necessary engineering data. Analysis of fluid flow is important not only in such obvious applications as design of boat hulls and bridge piers but also in many chemical engineering problems such as the distribution of fluids in a reaction vessel. It is even possible by polarization analysis of fluid flow to calculate the rate at which heat will be transferred from a solid to a liquid.

Within limits, the information obtained with liquid flow is applicable to gases, so that the method becomes useful in aviation and many other fields. Although there has been time for only a few applications of polarization analysis of fluid flow, one of these is providing graphic demonstrations for training aviators in flight theory. Another application has served to change the design of fireboxes in the locomotives of a western railroad.—*Industrial Bulletin* of Arthur D. Little, Inc.

WARPLANE PRODUCTION

Boosted by Automotive Technique of Zero Welding

In its quest for better products at lower cost, the automotive industry carries on extensive experiments to find new materials and new methods. Though such research often turned out, in the past, to be of no immediate use in the manufacture of cars and trucks, it is today being brought down from the "shelves" of the industry's laboratories to aid in the drive for more and better weapons for the United Nations.

Take the case of zero welding which is now being applied to the production of American warplanes, with a saving of thousands of precious hours.

The application of cold to the hot points of arc-welding devices stems from several automotive factories where it was tried in the manufacture of assembled sheet steel stampings. With the advent of war, automotive engineers, seeking short-cuts in aircraft production, revived the idea and began more thorough exploration. Such striking results were attained that all aircraft manufacturers became interested.

It was found, for example, that, in putting the 1600 spot welds on a single bomb-bay door, operations had to be halted more than 45 times to clean the welding points; but, with temperature of the electrodes reduced to zero, Fahrenheit, 800 successive welds were possible.

The total saving is estimated to be two and a half hours on just one bomb-bay door. And, as an operator and two helpers are required for welding this large unit, more than seven man-hours are thus saved. With four bomb doors

installed on each plane, the savings on this one part alone are considerable.

But, important though it is, time-saving is not the sole benefit of this welding technique. For, since there is less heat at the electrode tips, the aluminum alloy sheets are subjected to less heat expansion. There are, therefore, fewer buckled sheets. Moreover, as high temperatures in the electrodes tend to drive contaminating copper into the welds, the use of refrigerated tips produces stronger welds.

Zero welding came about when normal spot welding caused the grain structure of the aluminum alloy to change at the boundaries of the welds because of heat set up around the welding points. Such changes remained hidden until later stresses revealed them as cracks or breaks.

After a series of experiments with ways to defeat the destructive effect of heat, automotive engineers built a refrigeration device which was capable of pulling the temperature down to 85 degrees below zero.

Then experiments in welding began on sheets of various thicknesses, and at tip temperatures ranging from 25 degrees to minus 85.

As the engineers went to the lower temperatures they were balked by the formation of ice at the welding tips. To counteract this effect, they allowed acetone in the refrigerating system to squirt on the electrodes.

Every step of the experimentation was carefully documented so all companies engaged in aircraft work could profit from the experience. All the experimental welds were rigorously tested, and a library of photomicrographs was compiled on the subject. In addition, time-savings methods were devised for the mechanical cleaning of the parts to be welded as well as a simple method of cleaning and restoring the contour of electrodes without removing them from the machine.—*Automotive War Production.*

HIGH-SPEED X-RAY
Used in Production
Examination of Castings

A NEW mass production X-ray machine capable of inspecting as many as 17,000 airplane castings in a 24-hour day has been developed for a mid-western war plant, according to Westinghouse engineers.

"This revolutionary machine, which brings the advantages of assembly line speed to X-ray work, makes it possible to X-ray metal castings for defects at a rate of one every five seconds," explains C. V. Aggers, Manager of the X-ray Division of the Westinghouse Electric and Manufacturing Company, which developed the new unit.

Key to this new unit's speed is a moving conveyor 40 feet long and three feet wide that transports the castings through the X-ray inspection and provides the fastest method yet devised to spot flaws in large quantities of metal parts, says Mr. Aggers, adding:

"This unit produces an exposed film of six castings every 30 seconds—or the

equivalent of one casting every five seconds—to provide an almost continuous flow of exposed film ready for developing. When developed, each film shows an inside view of the six castings. The faulty castings with 'blow' holes, cracks, and other defects then can be weeded out, so that no man-hours or machine-hours will be wasted on imperfect castings."

Designed to inspect both engine and fuselage castings up to five inches in thickness, the mechanism includes two steel towers, each 12 feet high and situated near the middle of the conveyor, inside which the actual X-ray inspection is conducted. Each tower houses an X-ray tube—one tube operating at 140,000 volts, the other at 220,000 volts—so that castings of different types and thicknesses can be examined at the same time.

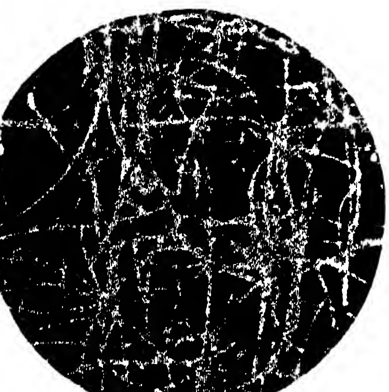
"The castings move along the conveyor on trays that halt automatically under the X-ray tubes," Mr. Aggers says. "A lead-lined protective device shields workmen from X-radiations while the exposure is made, and the castings then continue along the conveyor. For quickly identifying any defective castings, corresponding numbers are given the film and the castings."

GLASS FIBERS
Now Available in Seven Basic Types

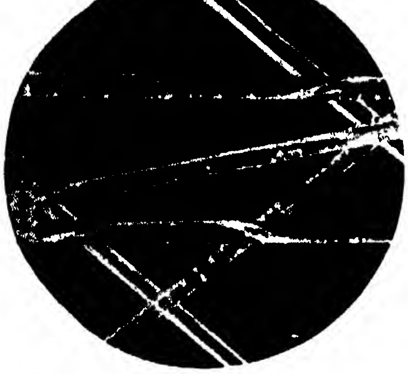
In the belief that they may find new and important military uses, and that they may assist manufacturers in the development of new post-war materials, Owens-Corning Fiberglas Corporation has made available seven basic types of glass fibers. These fibers are offered as raw materials for use with other fibers and with plastics and cements, and for use in various types of industrial and chemical process equipment.

Such possible applications of glass fibers have been by no means completely explored, and it is realized that the number is so great that Owens-Corning cannot hope to develop, or even adequately explore, them all. It is hoped that availability of the fibers will lead manufacturers to experiment with them, both to meet current urgent needs and with a view to post-war products and markets.

Fiberglas fibers are now being used in combination with plastics where they



One of seven—curly glass fibers



Another glass-fiber form—straight

serve as reinforcement for light-weight, high-strength structural parts for aircraft. The Fiberglas-plastic parts can be molded at low pressures, reducing fabrication costs and man-hours. Experience indicates, the company says, the adaptability of the fibers to similar use as reinforcement for certain cements and plaster-like materials where their high tensile strength may give improved physical properties to the resulting product.

Another potential field of use is the admixture of the glass fibers with other fibers, as in felts and papers. It is believed that the high tensile strength and non-stretching and non-shrinking characteristics of glass fibers will contribute new and valuable properties to other fiber and textile materials if means can be found to combine the raw fibers economically. Fabrics combining glass with cotton, rayon, and asbestos are now manufactured by combining the yarns of the desired types.

Filtering of air or gases, liquids and sludges by the straining method is cited as another possible use of glass fibers. The substantially cylindrical, smooth-surfaced fibers provide comparatively low resistance to the flow of liquids, yet the interstices between fibers may be modified to provide almost any degree of porosity.

Still other potential processing uses are contact applications in which water is sprayed on the fibers to humidify or dehumidify air that is forced through them, and eliminator applications where the fibers are employed to gather free particles of water or other liquids entrained in the air stream.

The seven basic glass fibers now available are distinguished by differences in fiber diameter, tensile strength and the glass compositions employed. Four glass compositions are used to provide different properties required for different applications.

PLASTICS IN BUILDING
Not Suitable for Load-Bearing Applications

The use of plastics as load-bearing materials to take the place of steel and wood, bricks or concrete, is a subject on which there has been some misconception in the minds of the public. For such purposes the choice of plastics is limited. Thermoplastics soften at quite

low temperatures, and the risk of collapse in case of fire makes it impossible to contemplate their use in load-bearing structures. That leaves only the thermo-setting plastics for consideration.

Thermo-setting plastics have the disadvantage that they are lacking in ductility of which a modicum is needed in structural materials to smooth out stress concentrations and to give timely warning of overloading.

The effect of lack of ductility is strikingly shown by some experiments on plastics as reinforcement for concrete made at the Building Research Station. It was found that on loading a concrete beam reinforced with plastic rods the stress was likely to be concentrated in one rod until it broke, throwing the whole load on to another rod, which broke in its turn. The result was that the tensile properties of the reinforcement were not fully utilized and the beam tended to break suddenly without warning. It was concluded that a flat slab reinforced in this way would be dangerous if it were accidentally overloaded, so the experiments were discontinued. In time new developments may change the position, but for the present plastics generally cannot be considered to be eminently suitable for structural use in building—*Highway Research Abstracts.*

PACKING RINGS
Made of New Materials
For Food Containers

RUBBER technicians have developed jar-sealing rings of non-critical materials that are enabling commercial food packers to conserve large quantities of foodstuffs that might otherwise be wasted, the research division of The B. F. Goodrich Company recently announced.

"In answer to an appeal by the nation's canners for sealing rings to replace rubber ones now denied by government restrictions for all but most essential uses, we have succeeded in producing two different types of rings which have proved satisfactory and which are already in mass production," Dr. Howard E. Fritz, director of research for the company, says.

One type of ring used for low heat packs is made of Koroseal, a thermoplastic material made basically of coke, limestone, and salt which was originated by Goodrich chemists. The other is a vulcanizable linseed oil compound combined with various secret ingredients. Both are being used by leading food processors and have already provided satisfactory seals for hundreds of thousands of cases of food products.

The sealing rings were developed, he explains, when the canning industry, seeking a replacement for tin cans when limitations on their manufacture became drastic, developed a special glass jar with a glass lid and then found that an air-tight seal could not be obtained by glass-to-glass contact.

Use of the new sealing rings has been confined to packing products which do not rate rubber rings, but

whose processors are able to obtain a fairly high priority rating for use of materials substituting for rubber. They are not available for household canning purposes.

LENS CEMENT

Replaces the Widely Used Canada Balsam

A NEW photographic lens cement developed by the Eastman Kodak Company has proved so much more effective than cement made from natural Canada balsam that the Army Air Forces have changed their lens specifications accordingly.

This development resulted from the fact that an alarming number of lenses in the combat areas were breaking up, discoloring, and being rendered useless because of the extremes in temperature encountered in desert fighting and stratosphere flying.

Aerial cameras, designed to penetrate camouflage and haze, and to record information as to enemy movements, depend upon highly perfected lenses. The

Components of an aerial lens, with bottle of new lens cement at right

completed lenses in turn consist of several component lenses which perform only as well as the transparent cement which holds them together. The cement must do its job under desert temperatures of over a hundred degrees and at high altitude temperatures of 50 to 60 degrees below zero. It must likewise be able to withstand a quick temperature change of more than a 150 degrees.

When investigation showed that the cementing method previously used was responsible for lens destruction and discoloration, the Eastman Kodak Company undertook research which lasted over two years and which resulted in submission of the new product to the Army Air Forces.

JEWEL COUNTING

Speeded by Use of Simple Device

COUNTING tiny glass jewels used in the manufacture of aircraft instruments would be a tedious job but for

Counting 1000 jewels at a time

an ingenious yet simple counter used at one of the General Electric's plants. The operator dumps the pin-head jewels into a tray, gives it a rock back and forth which allows but a single jewel to fall into each small hole, then pulls the slide in the front and 1000 jewels fall into a tray below. Thus in a few seconds she counts 1000 of these small jewels which otherwise would take several minutes. A gallon jug will hold 550,000 of these jewels.

POROUS CHROME

Plating Used on Engine Piston Rings

RECENT removal of certain censorship restrictions has permitted the release, by the American Hammered Piston Ring Division of Koppers Company, of an outstanding example of the "tremendous trifles" of industry which are playing such an important part in American war successes.

By plating airplane piston rings with .005 of an inch of chromium (about the thickness of a sheet of book paper) on the cylinder contacting surface, our fighting aircraft have been able to fly five times as many hours between engine overhauls.

Tightly locked on special arbors, the piston rings are lowered, by an overhead traveling crane, into one of a long series of tanks. Said to be the largest chromium plating department in the world, the operation is based upon the Van der Horst process. (See page 112, September 1943 Scientific American.—*Editor.*) While experimental work pre-dates the war, the present department, with its block-long line of plating tanks and generators, was planned immediately following Pearl Harbor, and has been in actual operation for over a year.

The "chrome" on airplane rings is not the bright, hard, plating used on automobile bumpers. Instead, it is known as "Porus-Krome"—gentle on cylinder walls, permitting ample lubrication, and yet resisting wear to an extent that, if applied to industrial engines in postwar days, has long-life potentialities beyond any piston ring set-up ever before known in the trade.

Current Bulletin Briefs

Conducted by
K. M. CANAVAN

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

Testimony To The Future is a 20-page cross-sectional report of post-war industrial research based upon information obtained from member-companies of the National Association of Manufacturers. It outlines the importance of such research and its implications for the average person and for industry at large. *The National Association of Manufacturers, 14 West 49th Street, New York, New York.—Gratis.*

Measuring and Control Instruments is a 16-page illustrated bulletin which describes a complete line of temperature controllers and explains the "electronic principle" used for effecting control without contact between the measuring and control functions. Remote controllers, combustion safeguard equipment, and other instruments are also covered. *Wheelco Instruments Company, Harrison and Peoria Streets, Chicago, Illinois.—Gratis.*

The Observer's Handbook for 1944 contains data on the planets and other astronomical phenomena month by month; lists of double and multiple stars; variables; four star maps; an ephemeris of the Sun; and other data to the extent of about 80 pages. Most amateur astronomers obtain this booklet each year. *Royal Astronomical Society of Canada, 198 College Street, Toronto, Ontario, Canada.—25 cents.*

Cascophen Lt-67 is an eight-page bulletin dealing with the characteristics of liquid phenol-formaldehyde resin glue which is claimed to be the most durable type now in use and to be applicable in the construction of aircraft, barges, boat keels, and other wood products. *Casein Company of America, 350 Madison Avenue, New York 17, New York.—Gratis.*

Safe-T-Grip Fuse Pullers is a single sheet describing a new type of insulated pliers for use in handling fuses, as well as other fuse devices. *Ideal Commutator Dresser Company, 1288 Park Avenue, Sycamore, Illinois.—Gratis.*

Insulated Materials Catalog is a 60-page illustrated handbook covering an entire line of insulating materials including varnished cloths, tapes, tubings, mica, and cements and compounds. *General Electric Company, Bridgeport, Connecticut.—Gratis.*

Radiography of Materials is a 100-page plastic bound book which provides a concise yet elementary text describing the basic physical and chemical principles of radiography as applied to the non-destructive examination of materials. Also covered are the fundamental requirements for efficient application of the method. A short bibliography is included. *Eastman Kodak Company, Rochester 4, New York.—Request this bulletin on your business letter head.—Gratis.*

Light From Floors is a 24-page illustrated bulletin describing a new type of light-reflecting concrete floor which becomes a giant reflector instead of the usual giant absorber of light. Examples show the advantages in overall lighting efficiency of white-cement floors and how such floors promote easier seeing by reducing lighting contrasts. *Universal Atlas Cement Company, Chrysler Building, New York, New York.—Gratis.*

New Tools for Learning is a 28-page bulletin which offers a coordinated program of pamphlets, radio transcripts, films, and recordings on vital problems. The section on "Postwar Problems" is of particular interest. *New Tools For Learning, Seven West 16th Street, New York, New York.—Gratis.*

Trail Blazers to Radionics and Reference Guide to Ultra High Frequencies is a two-part booklet of 30 and 56 pages respectively. The first part presents short biographical sketches of those scientists and technicians who have been particularly active in the development of radio. The second part is essentially a bibliography of articles on the subject of ultra high frequencies which have appeared in United States and foreign publications. *E. Kelsey, Zenith Radio Corporation, 480 North Michigan Avenue, Chicago 11, Illinois.—Gratis as long as supply lasts.*

Jansson Handbook of Precision Measurement is a 60-page illustrated booklet which gives, in the first chapter, a history of measurement and then continues on through precision measurements with various instruments and with gage blocks. *Jansson Gage Company, 19208 Glendale Avenue, Detroit, Michigan.—Gratis.*

Coated Abrasives is a 68-page general catalog on the subject of various forms of abrasive belts, disks, sleeves, cones, sheets, and so on. Included is a considerable amount of information on the overall subject of coated abrasives and their applications. *Armour Sandpaper Works, Chicago, Illinois.—Gratis.*

Here's A Grinding Wheel . . . is an illustrated folder describing a line of open-structure grinding wheels which, used on certain types of jobs, can speed up production by making it possible to obtain uniform results on each grind. *Norton Company, 100 New Bond Street, Worcester, Massachusetts.—Gratis.*

Conserve for Victory With Near Infra-Red is a 12-page illustrated issue of a house publication dealing specifically with the use of near infra-red for industrial heating and similar operations. The illustrations show typical applications, while drawings give specific uses. *The Fostoria Pressed Steel Corporation, Fostoria, Ohio.—Gratis.*

New Products

SCRATCH ELIMINATOR

Developed for eliminating scratches which occur during the fine-grinding operation in the processing of lenses and prisms, Col-Emeroid is a product which, when used in the fine grinding process, acts as a deflocculent, keeping the emery finely suspended and preventing the emery from coagulating into larger sized particles. Thus it eliminates the tendency for scratching. It also enables the emery to be broken down more finely, thus leaving a smoother finish on the glass. This in turn decreases the time necessary for polishing out the surface. It also acts to eliminate caking of the emery when left standing for any length of time

Col-Emeroid, according to the makers, Optical Engineering Laboratories, can be used directly with the emery, instead of water, or it may be diluted with water, using one part to four or five parts of water, but the exact proportion is not critical.

RESISTOR COIL COATING

A new type low-loss resistor coating that will be marketed under the trade name of Lectraseel is a vitreous coating that is highly resistant to thermal shock. Accelerated weathering tests indicate that a coil coated with Lectraseel is immune to corrosion and should give satisfactory low-loss service over a long period even under adverse conditions.

FILTER PHOTOMETER

A new "Photelometer" of small size for industrial use, with sensitivity and accuracy sufficient for most laboratory determinations, has been developed by the Central Scientific Company. The instrument is a compact filter photometer for chemical analyses in the routine or control laboratory. Molybdenum, titanium, vanadium, or manganese in steel, lead, copper, iron or vitamins in foods are a few typical determinations to which this unit lends itself.

The "Photelometer" is easily standardized by determining the transmittancies of a number of solutions which are prepared in accordance with a specific chemical procedure. The transmittancies, when plotted on a semi-logarithmic scale against the known concentrations on a linear scale, yield the analytical curve or standard with which unknown solutions may be compared.

For routine or control laboratory

COMBUSTION FURNACE

Incident to the stepped-up production of high-octane aviation gasoline essential to the war program, the Universal Oil Products Company has developed a multiple-unit electrically heated combustion furnace offering several novel features. The equipment is manufactured and offered commercially by the Precision Scientific Company.

Although originally designed specifically for the determination of carbon in cracking catalysts used for producing high-octane aviation gasoline, the equipment is modifiable to handle a wide variety of organic combustions within the temperature limit of 1000 degrees, Fahrenheit.

One of many possible assemblies

The equipment comprises an oxygen purification system for combustion gases; an oxygen pressure regulating column; and an electrically heated furnace 24 inches long, with four combustion tubes 1 inch in diameter by 30 inches long. Heating intensity for each half of each tube is independently controlled, and temperature of any tube can be readily observed by means of an indicating pyrometer. Conventional absorption trains, with calcium chloride for absorption of moisture and Ascarite for removal of carbon dioxide, are also used.

The assembly illustrated is merely representative of other multiple assemblies, which can be built up to suit the job involved.

METALLURGICAL CHECKING

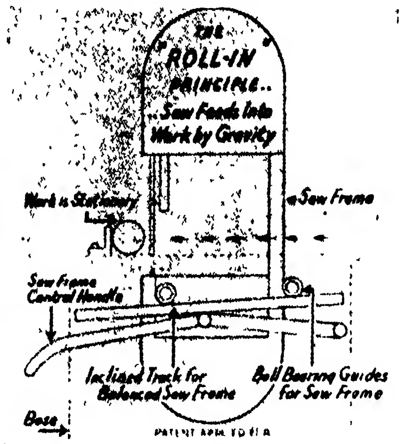
An entirely new electronic means of checking and sorting metals for depth of case-hardening and other metallurgical factors, has already undergone extensive trials and has won the keen interest of metallurgists, ordnance experts, and industrialists. It is based on the use of the Du Mont Cyclograph,

a cathode-ray instrument which provides a visual means of checking and comparing known and unknown metallurgical items.

The Cyclograph, by the use of several frequencies, either one after the other or simultaneously, checks or compares known and unknown metal pieces according to such factors as case depth, depth of decarburization, amount of cold-working, brittleness (stress gradients), hardness gradients, structure, and so on.

NOVEL BANDSAW

A "GRAVITY-FEED" metal cutting bandsaw, recently announced, is so designed that the saw blade feeds into the work through movement of a balanced blade wheel frame on an inclined track. Blade pressure is automatically regulated by texture and degree of hardness of metal being cut and requires no



Saw moves; work is stationary

attention from operator. This largely eliminates blade breakage due to incorrect pressure.

This new saw, made by the Universal Vise and Tool Company, is adaptable for cut off, trim, and contour work. It has a maximum cut of 7 inches vertically, and the blade travels 7 inches into the work.

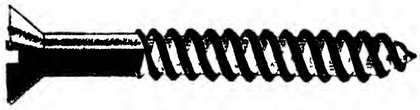
WETTING MATERIAL

DEVELOPED to improve the action of water on the gummed surface of tape employed in sealing operations, a new wetting material called Aquaflux is added to the water in proportions governed by the water hardness.

TWIN THREAD SCREW

A NEW patented screw for wood, plastic, and combination assemblies, known as the Twin-Fast Screw, has two parallel threads which start at opposite sides of the shank and terminate in a single, centered point. The twin-thread construction affords a far greater thread pitch than does the conventional screw, so that the driving speed is doubled. Yet the driving torque is only nominal, since the twin-thread construction provides the standard number of threads per inch.

An added advantage for plastic assemblies is that Twin-Fast Screws,



Double thread, cylindrical contour

made by The Blake and Johnson Company, are self-tapping. They cut their own clean, full threads. The Twin-Fast Screw is cylindrical in contour (not tapered), giving the screw greater strength. Also, the thread area is increased, providing more extensive contact, tighter seating, and greater holding power than with tapered screws.

The relieved shank diameter of Twin-Fast Screws acts to eliminate stresses which may be set up by the shank and cause fractures or ruptures.

SPRING TESTER

A NEW tool for testing compression springs in sizes to 2½ inches diameter and 7 inches in length not only makes it possible to measure rapidly the recoil pressure of springs when compressed to any predetermined length, but makes it possible to accurately match sets of springs, as for use as valve springs in gasoline engines.

The Sturtevant Spring Tester is operated with any accurate standard torque wrench, the torque wrench not only serving as the operating lever, but also providing the measuring element The compression of spring is against a rigid platform to prevent accumulated errors in reading.

Developed originally as a means of accurately matching valve springs of airplane and automotive engines, the first of these tools in the field are finding a much wider range of application. They are being used not only for testing springs of all sorts within their capacity, but also for proof-testing strength of press fits and for light arbor press production operations where they permit the rapid application of accurately gaged pressures.

RAPID METAL COATING

DEVELOPED to expedite application of the heavier silver coatings now specified on many government projects, for bus bars, lugs, and other parts of electrical equipment, a new rapid metal-coating process is also useful for plating, replating, or touching up rust and corrosion-resistant coatings of other metals, on production lines or in the field. The system is available for use of silver, cadmium, tin, copper, zinc, nickel, and gold.

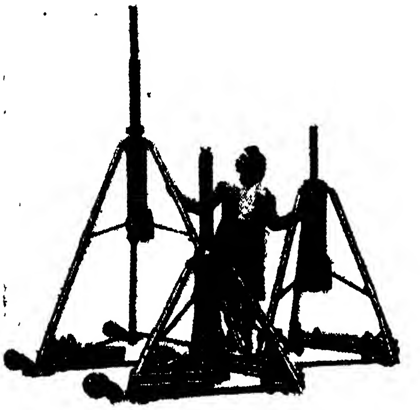
Quick and positive in operation, the

Simple equipment for rapid plating

equipment requires only three basic items: (1) rapid electrolyte; (2) rapid metal cleaner; (3) rapid applicator. Plating current for small jobs can be obtained from dry batteries, storage battery, or any convenient source supplying direct current at three to six volts. A special rectifier is recommended for large quantities of work. Standard applicators are available in three sizes; special applicators can be made to order to facilitate work in very close quarters, or for unusual requirements on production lines.

MANY-HEIGHT JACK

How one jack can be adjusted to a variety of heights to eliminate the need for a variety of jacks is shown in the accompanying illustration of a fast action Malabar variable height wing or nose jack. With only a wrench, the leg sections (attached to base) can be interchanged to add 18 or 36 inches to the minimum closed height. The basic minimum is offered in 36, 48, and 60 inch models, with hydraulic lifts of



Jack of many heights

from 24 to 34 and 44 inches. The 16-inch screw increases the versatility so that total extended vertical heights are 76, 98, and 120 inches respectively with minimum legs. These jacks are built with capacities of 5, 7½, 12, 17, and 25 tons.

SEALING TAPES

Literally thousands of miles of specially designed sealing tapes have already been furnished to the aircraft industry by the Paint Division of the Pittsburgh Plate Glass Company. Fabseal, Chromseal, and Stratoseal are made in rolls 50 feet long and in widths varying from one-half inch to 24 inches. The application of sealing tapes is a great deal faster than the application of caulking compounds with a putty gun or by hand. Thus many man hours are saved in the over-all construction of aircraft.

Fabseal is particularly designed for use as a gasket in the construction of flying boat hulls, and of gas and oil tanks where internal or external pressures are encountered under constant vibration or sudden impact. It is an impregnated fabric with an interleaf separating the fabric layers. Before the fabric is impregnated with compound, it is treated to make it water-, gasoline-, and oil-resistant to prevent wicking action. The tape may be applied to any metal or wood section of a fuel tank, pontoon, and so on, and after application the interleaf is removed, exposing the upper surface of the tape, which is then ready to receive another riveted or bolted section. Fabseal is .010 inches thick when compressed between surfaces under rivet or bolt pressure.

Chromseal is a solid ribbon of compound with no fabric as part of its composition, and therefore is more flexible than Fabseal. It is especially suited as a gasket material between riveted or bolted surfaces of integral fuel tanks, droppable reserve tanks, as well as a seal for plastic enclosures and glass cockpit framing. Chromseal can be molded by hand to conform to almost any angle, curve, or contour. It is also highly resistant to gasoline, oil, and water.

Stratoseal, as its name suggests, is designed for the sealing of the cabins of stratosphere-flying planes. In the construction of these cabins and fuselages every seam, joint, and door must be sealed against leaks, and the sealing material used must remain flexible in temperatures ranging from 70 degrees below zero to 150 degrees above zero. Stratoseal, also a solid ribbon of compound, meets these extreme conditions and remains flexible. It can be applied between overlapping metal joints or over the inside surface of the joints by the use of Stratoseal adhesive.

DUST CONTROL

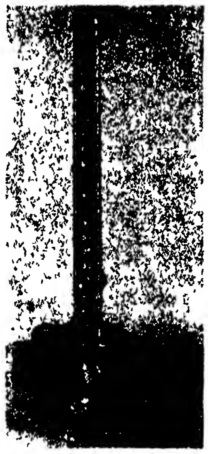
A new compound developed for laying airport dust is described as a stable homogeneous liquid of relatively low viscosity which may be diluted or extended with water in all proportions. The concentrate and its emulsions are said to be effective in wetting and penetrating all types of soil including moist earth.

According to the Research Director of the Curran Corporation, the new compound may be actually applied to a soft muddy surface immediately following a rain Because of a new type

of emulsifier used, the new oil will wet only the top two inches of the soil since it becomes water insoluble on farther penetration. Because of this property, the composition is not dissolved and leached away into the soil by a following heavy rain. The compound is also stated to be safe and easy to handle; is non-corrosive to metal and spray equipment, and contains an effective weed killer. The cost to use is said to be less than that of distillates or sludge oils.

RESILIENCY MEASUREMENT

Not only rubber technologists and research scientists but manufacturers and consumers of rubber products or other extensible materials often want to know just how much resiliency or "springiness" is possessed by the material in question. Resiliency may be roughly de-



Dropping a weighted plunger and noting the rebound gives a measurement of the resiliency of rubber and other extensible compounds

fined as the property which accounts for the "bounce" or rebound of a rubber ball, for example. It is of more than passing interest because it may be an index to other important properties. To measure resiliency is the function of an instrument known as the Resiliometer. manufactured by the Precision Scientific Company

Resiliency of rubber and extensible plastic compounds is indicated by the rebound of a weighted plunger dropped on the test specimen from a predetermined height. Resiliency tests are conducted in the development of rubber and extensible plastic compounds, for measuring rate and state of cure; matching competitive compounds; factory control tests on cured samples of mixed batches; quality tests of the finished product without destroying the product; comparing heat build-up of various compounds; measuring plasticity of uncured compounds and masticated rubber.

INSULATED-REFLECTIVE OVENS

Configurations of a wide variety, for application to specific drying problems, may be had with a new flexible type of infra-red oven. The parts of the oven are made up in stock blanks which can be grouped or re-grouped on the job to obtain the drying areas necessary for any specific work.

These ovens, made by Infra-Red Engineers and Designers, use standard incandescent infra-red lamps and also incorporate reflective panels which carom the heat rays to concentrate them upon certain parts.

SEAM-WELDING GUN

A new development in seam-welding in the form of an air-operated portable gun with which parts that are too big to "take to the machine"—and also large assemblies which are mounted in stationary fixtures—can be seam-welded, announced by Progressive Welder Company, is already in use welding 22-foot seams on disposable light-weight fuel tanks.

The machine has been designed for welding steel up to two thicknesses of 20-gage metal, including stainless steels The gun is universally suspended and can be swiveled about so that the operator can weld in almost any direction —horizontally or vertically.

Features of this new seam-welding gun include a head operated by an air motor using 42 cubic feet of air per minute under load. When the seam-welding gun is in operation, the air passing into the handle runs the motor Pushing the control button—which is located on the guide handle at the right of the gun—operates a solenoid switch, letting the air into the cylinder on the gun. This air cylinder has a diameter of 4½ inches, which is large enough to provide a maximum pressure of 1400 pounds per square inch with 90 pounds of line pressure, permitting the seam-welding of stainless steel.

The air flowing into the cylinder forces the upper and lower wheels together. The upper wheel is the idling wheel; the lower is the driven. When the air pressure reaches a pre-set value, the pressure switch starts the welding timer and the gun begins to seam-weld. The air motor runs continuously when the air is "on." Removing the pressure from the button control causes the solenoid valve to release the air in the cylinder. At the same time, the pressure switch cuts off both the timer and the welding current.

Air-operated head of welding gun

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with the names of available books, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for. Books listed in these columns may be ordered from our Book Department. Add 25 cents per book for mailing outside U. S.

TO MAKE CERTAIN that books ordered by or for men in the Army, located in the United States, or men in the Navy, located anywhere, will be delivered, insurance fees should be sent with orders, as follows: To \$5 in value, 5¢ additional; from \$5 to \$25, 10¢; from \$25 to \$50, 15¢.

FORWARD WITH SCIENCE

By Rogers D. Rusk

PHILOSOPHICAL discussions of developments centering around physics: Newly discovered particles; electron microscope; keeping up with X-rays; man-made radioactivity; atom smashing; atomic energy; cosmic rays; man outgrows mechanism; is Einstein outmoded?; astrophysics; does nature make sense?; science and war; remaking the world; human freedom and destiny. This book, by the professor of physics at Mount Holyoke College, sufficiently explains the above things but mainly it discusses their significance in our modern and future world. Thus it is more thought-provoking than mere fact-stating. (307 pages, 5½ by 8½ inches, 28 illustrations.)—\$3.60 postpaid.—*A.G.I*

TECHNICAL HANDBOOK

For Solving Problems in Shop or Factory

By Edward E. Lang

MATHEMATICS and science as applied to the industrial job — covering arithmetic, solving triangles, logarithms, simple machines, properties of materials, chemical computation, and so on — are presented in simple and concise form for easy study and rapid reference. (100 pages, 5½ by 8 inches, a large number of drawings, paper covers, and pages punched for standard three-ring binders.)—\$1.10 postpaid — *A.P.P.*

HOW THE ARMY FIGHTS

By Capt. Lowell M. Limpus

BE A SWIVEL-CHAIR strategist, or a better one. Typical chapters: Old Strategy—New Tactics; Control of the Modern Army; How Modern Armies Attack; Enshrouding the Machine in Secrecy; The New Logistics (to say plain "supply" for logistics today brands you as a back number—and don't say "orders" for directives, else the Armchair Experts' Union will pitch you out); How Modern Armies Attack; The Changing Tempo of Modern War. Main emphasis in this book is on the new in warfare. Author is a West Point man and this is an easy version, in chatty style, of what's taught to modern military officers, enabling the reader to estimate correctly what's behind the unconscious distortions of the daily newspaper and the-people-who-don't-understand. (388 pages, 5½ by 8⅜ inches, 31 illustrations.)—\$3.10 postpaid.—*J.P.C.*

FUNDAMENTALS OF SHOPWORK

By William H. Johnson and Louis V. Newkirk

COMPREHENSIVE indeed is the simplified text of this book covering such phases of shopwork as hand and machine tools, measuring and gaging, woodworking and metalworking, wiring and wire splicing, ropes and knots. Although designed as an introductory course for Army technicians, this book will be welcomed by every "home mechanic" (200 pages, 8½ by 11½ inches, lavishly illustrated)—\$2.10 postpaid.—*A.P.P.*

THE MICROSCOPE AND ITS USE

By Munoz and Charipper

TECHNICAL book in non-technical language. Chapters on: Evolution of the microscope; modern microscope; illumination; microtomes; use and care of microscope; stereoscopic microscope; metallurgical microscope; polarizing microscope; accessories; common errors in use; glossary; bibliography. This book would not satisfy (1) experts (2) kids (3) dabblers. It should satisfy adult beginners, at least for a year or so, when they will begin crying for more detail, for it omits theory and presents practice alone. (334 pages, 5½ by 8½ inches, 122 illustrations.)—\$2 60 postpaid.—*A.G.I.*

RADIO — II.

By R. E. Williams and Charles A. Scarlett

PICKING up where Volume I (recently reviewed in these columns) left off, the present text deals with vacuum tubes and their applications, microphones and loud speakers, transmitting equipment, antennas, cathode-ray oscilloscopes, and so on, all presented in a simplified and understandable form, designed to complement the pre-induction training course in fundamentals of

The Editors Recommend

Best Sellers in Science

PLASTICS — *By J. H. Dubois.* Revised and enlarged edition of an important work on the whole general subject of plastics, plus much new material on synthetic rubber, manufacturing processes, and plastic molding. **$3.85**

EXPERIMENTAL ELECTRONICS — *By Ralph H. Muller, R. L. Garman, and M. E. Droz.* A solid book of eminently practical information on the characteristics and non communication applications of electron tubes. The text describes experiments and presents results. For students, radio engineers, communications experts, and the serious general reader. **$4.75**

ATOMS, STARS, AND NEBULAE — *By Goldberg and Aller.* One of the "Harvard Books on Astronomy." An elementary treatise on astrophysics, neither light nor too formidable for readers familiar with elementary astronomy. **$2.60**

GET TOUGH! — *By Capt. W. E. Fairbairn.* How-to-win-in-hand-to-hand-fighting directions, by a man who really knows rough and tumble methods that are *not* "clean" fighting but *are* designed to win. **$1.10**

COLLEGE PHYSICS — *By Henry A. Perkins, Sc.D.* Revised second edition (unabridged) of a textbook which places emphasis on the difficult portions, on the old physics instead of modern corpuscular physics, and on principles rather than concrete phenomena. **$6.10**

LEARNING TO NAVIGATE — *By Weems and Eberle.* For those totally inexperienced or only casually familiar with the fundamentals of navigation, this text will provide a practical handbook leading to an understanding of navigation at sea or in the air. A number of illustrations and tabulations **$2.10**

FUNDAMENTALS OF RADIO — *By Jordan, Osterbrock, Pumphery, and Smeby.* With this one volume alone, and with some diligence of application, it is possible to obtain a thorough grounding in radio principles. In thoroughness of treatment, with due respect for the needs of the reader, this book is outstanding. **$5.10**

FUNDAMENTALS OF ELECTRICITY — *By a Staff of Electrical Experts.* Although designed to supply men about to enter military service with a foundation for further training, this text will serve a similar purpose for anyone desirous of acquiring such knowledge. **$2.10**

ELEMENTS OF ORDNANCE — A textbook prepared for cadets of the United States Military Academy. Covers manufacture, the chemistry of explosives, types of weapons, mathematics of ballistics, etc. **$6.60**

AIRCRAFT INSTRUMENTS — *By George Ellis Irvin.* All types of instruments for aircraft use described for students, pilots, inspectors. Fundamentals, instructions. **$5.10**

MARINE DIESEL HANDBOOK — *By Louis R. Ford, M.A.* A compendium of data on design, construction, and operation of the marine Diesel engine with chapters covering applications, principles, types, fuel injection systems, lubrication, supercharging, and so on. **$7.25**

MACHINERY'S HANDBOOK—*Eleventh Edition.* "Bible of the mechanical industry," enlarged to 1815 pages of latest standards, data, and information required daily in the shop and drafting room. **$6.10**

PROCEDURES IN EXPERIMENTAL PHYSICS — *By John Strong, Ph.D.* A wealth of useful data of a practical kind for the constructor, experimenter, and skilled craftsman. **$6.80**

STEEL SQUARE POCKET BOOK — *by Dwight L. Stoddard.* Practical methods for using the carpenter's steel square for layout work of all kinds. Time-tried methods used by two generations of carpenters and found both rapid and accurate. **$1.00**

REFINING PRECIOUS METAL WASTES — *By C. M. Hoke.* A practical book, based on experience, dealing with processing, identification, and repurification of such metals as gold, platinum, silver, alloys, iridium, and rhodium. **$5.10**

WORKING WITH THE MICROSCOPE — *By Julian D. Corrington.* For the serious beginner. Explicit, practical. **$3.60**

TOOL MAKING — *By C. B. Cole.* Instructions for making and using all kinds, from personal tools to arbor presses, lathes, planers, etc., in different metals. **$3.60**

THE ELECTRON MICROSCOPE — *By Burton and Kohl.* A well written account of this newest tool of science, with all technicalities explained for complete understanding by average persons. **$3.95**

ENCYCLOPEDIA OF KNOTS AND FANCY ROPE WORK — *By Granmont and Hensel.* More knots are described in this remarkable book than in any book on seamanship ever published or dreamed of. 3257 knots are illustrated in half tone reproduction and are described in the text. **$5.10**

A MATHEMATICS REFRESHER — *By A. Hooper.* Prepared mainly to refresh aviation trainees whose high school mathematics is rusty. Scope - arithmetic through calculus. **$2.60**

PLASTICS, PROBLEMS AND PROCESSES — *By Mansperger and Pepper.* The whole story of plastics, including a resume of manufacturing processes and a number of thorough-going chapters devoted to plastic uses **$3.10**

AUTOMATIC ARMS — *By Melvin M. Johnson and Charles T. Haven.* Comprehensively covers machine guns, machine rifles, sub machine guns, pocket pistols, shotguns, sporting, military rifles in automatic classification. **$5.10**

MIRACLES OF MILITARY MEDICINE — *By Albert Q. Maisel.* The drugs, devices, and techniques used in the services **$2.85**

HANDBOOK OF CHEMISTRY AND PHYSICS — A classic reference book recently revised and brought up to-date to keep pace with recent research. Includes material on all branches of chemistry, physics and allied sciences. Used in laboratories and by engineers throughout the country. Flexible binding. 2503 pages **$4.10 Foreign $4.50, postpaid**

ATOMIC ARTILLERY — *By John Kellock Robertson.* Electrons, protons, positrons photons, neutrons, and cosmic rays, all described for the layman in plain language. Also transmutation of the elements and the manufacture of artificial radio activity **$2.35**

● The above prices are postpaid in the United States. Add, on foreign orders, 25¢ for postage on each book, except as noted. ●

For Sale by: December, 1943

SCIENTIFIC AMERICAN, 24 West 40th Street, New York 18, N. Y.

I enclose $. . . for which please forward at once the following books:

. . . .

. . . .

Name . . . .

Address . . . .

Write us for information on books on any subject. We can supply any book in print.

radio as prepared by the War Department. (170 pages, 6½ by 9½ inches, a number of drawings, photographs, and tabulations.) — $1.35 postpaid. — *A.P.P.*

BASIC PHYSICS FOR PILOTS AND FLIGHT CREWS

By E. J. Knapp

DESIGNED to give a thorough yet rapid grasp of the fundamental physics necessary for preliminary aviation training, the text of this book follows an outline set up by the Civil Aeronautics Administration. Interestingly written and sufficiently simplified for use as a self-study course. (118 pages, 5 by 8 inches, thoroughly illustrated.) —$1.75 postpaid.—*J.P.C.*

GLOSSARY OF SHIPBUILDING AND OUTFITTING TERMS

By W. J. Eddington

FROM A to Z, an extensive dictionary of living maritime definitions written by an actual, not an armchair, seaman from the modern merchant marine and with emphasis on the practical and not the romantic. Appendix gives list of deck department, engine room, and machine tools. (435 pages, 5 by 7¼ inches, illustrated.)—$3.60 postpaid.—*A.G.I.*

ELECTRONIC CONTROL OF RESISTANCE WELDING

By George M. Chute

ELECTRON tubes and their circuits for the control of resistance welders are presented here in practical and relatively simple form. The text is designed to aid those men who work with and maintain these controls in industry (389 pages, 6½ by 9½ inches, a number of drawings and a few photographs.)—$4.10 postpaid—*A.P.P.*

FUNDAMENTALS OF ENGINEERING DRAWING

By Warren J. Luzadder

AIMED at the mental level of technical students and professional draftsmen, the text of this book covers the general subject of its title from the selection of drawing materials and equipment through engineering geometry, technical lettering, the theory of projection, symbols, design problems, and technique to an appendix which gives a number of tables of valuable engineering data. (568 pages, 6½ by 9½ inches.)—$4.10 postpaid.—*J.P.C.*

MAN'S UNKNOWN ANCESTORS

By Raymond W. Murray

NONE of the numerous books on ancient man that this reviewer has read in the past 22 years gave so generous and inclusive a round-up of the notable discoveries, and of some of the less well-known finds, as this—not even for one hemisphere; while this very well-rounded work covers both Old World and New World discoveries equally well and for the whole time

scope, early to late. It details each discovery, discusses it, cites salient opinions, arguments, and disputes about it, giving the most recent consensus, thus bringing the whole subject up to date. It is not a light work, nor on the other hand is it a pedantic or professional book, but lies between these levels. About this new book it is possible to enthuse a great deal. (384 pages, 6 by 9 inches, 37 illustrations.)—$3.60 postpaid.—*A.G.I.*

SLIDE RULE SIMPLIFIED

By C. O. Harris

How to use a slide rule in all of the many applications to which this tool of the engineer can be put. The author has gone to great length to simplify slide-rule applications, instead of shrouding it in the mystery that so often surrounds it, using a large number of illustrations to make the whole matter perfectly clear. (250 pages, including practice problems and answers; 6 by 8½ inches; heavily illustrated.)—$3.60 postpaid including genuine Dietzgen slide rule; $2.60 postpaid for book alone.—*A.P.P.*

PRIMER OF CELESTIAL NAVIGATION

By John Favill

Elementary textbook for seamen-to-be or aviators-to-be; being the second edition of a successful treatise. Without frills, it is a solid book of good hard work, with many practical problems, and a lucid exposition of that work. (263 pages, 5 by 7 inches, 43 illustrations.)—$2.10 postpaid.—*A.G.I.*

AIRCRAFT MATHEMATICS

By S. A. Walling and J. C. Hill

Not a textbook of mathematics but rather a selected presentation of those phases of the science which are essential to air cadets and others interested in the technical aspects of areonautics. Although British in origin, the "translation" of specialized terms into American phraseology should not be a deterrent to the use of this compact volume. (189 pages, 5½ by 7½ inches, a number of drawings.)—$1.85 postpaid.—*A P P*

DRYING AND DEHYDRATION OF FOODS

By Harry W. Von Loesecke

Technological treatise for the industry rather than for home users. Compilation of the latest practical information dealing with this subject. Author is senior chemist, Bureau of Agriculture, Chemistry and Engineering, United States Department of Agriculture. (302 pages, 6 by 9 inches, 64 illustrations.)—$4.35 postpaid.—*J.P.C.*

SELL YOUR PHOTOGRAPHS

By Eugene Wyble

This manual for free-lance photographers was written for those with an interest greater than that of a casual snapshooter. All rose-colored statements that breed wishful thinking have been left out. Chapters are devoted to equipment needed, how to prepare and use ideas, how to create a story-telling picture, how to finish prints, and where and what the markets will be. This is a book to guide those seriously interested. (167 pages, 5½ by 8 inches, unillustrated.)—$2.10 postpaid.—*K.M.C*

SHIPBOARD MEDICAL PRACTICE

By W. L. Wheeler Jr., M.D.

Handbook of ship sanitation and emergency medical aid at sea. As it is written expressly for common seamen and not for doctors, it is free from medical jargon. It covers such subjects as survival on uninhabited islands, care of disaster victims, radio messages requesting medical advice, and ship sanitation. Everything needed is put together in this one thin little pocket-size book. (114 pages, 5 by 7½ inches, 16 illustrations.)—$1.10 postpaid.—*J.P.C.*

SCIENCE, RELIGION, AND THE FUTURE

By Charles E. Raven, D.C.

Eight lectures on: The new philosophy of seeirg life whole; childhood of science; conflict of science with religion; ravages of war; new reformation; the intellectual, moral, and religious tasks. Antagonism of science and religion and what to do about it is the central subject. (125 pages, 5 by 7½ inches, unillustrated.)—$2.10 postpaid.—*A.G.I.*

ENCYCLOPEDIA OF SUBSTITUTES AND SYNTHETICS

By Morris D. Schoengold

Encyclopedic in scope, indeed, is this reference book which covers largely those products which have been developed recently to replace critical materials. The text discusses substitutes in all branches of industry and pharmaceutics, including comprehensive explanations of plastics and other synthetics. Particularly aimed at industrial and laboratory chemists but of outstanding usefulness to anyone whose work deals with industrial materials. (382 pages, 6 by 9½ inches, unillustrated)—$10 10 postpaid—*A P P*

UNDER A LUCKY STAR

By Roy Chapman Andrews

Lifetime of scientific adventure retold by the famous leader of the Mongolian expeditions (dinosaur's eggs) of the American Museum of Natural History. Few know the rest of this man's life, which has been saturated with travel and adventure as most of us only wish we could live. (300 pages, 5½ by 8¼ inches, unillustrated.)—$3.10 postpaid.—*A.G.I*

PRE-SERVICE COURSE IN MACHINE SCIENCE

By Samuel H. Lebowitz

Divided into 14 chapters, the text conforms in content to the corresponding sections in the Course on Fundamentals of Machines as established for pre-induction training. Physical and chemical principles are dealt with

simply yet forcefully and are specifically related to practical applications in machine science. Altogether, this text is one which will provide a firm and solid foundation for further study. (440 pages, 6 by 9 inches, 200 illustrations, well indexed.)—$2.60 postpaid.—*A.P.P.*

SCHOOL OF THE CITIZEN SAILOR

By Bolander, Fletcher, Gabriel, and Second Army Board

About the complex organization of the Navy, presented by the associate librarian at the U. S. Naval Academy, but chiefly on the economic, political and historical background of World War II. The 190-page section on American History and the Constitution, by Professor Gabriel, is an outstandingly objective presentation of those parts of our nation's development best chosen to give the adult reader (for this is no schoolbook) a clear, full, deep comprehension of what and how much he is fighting for. Suitable for men of the more serious, thoughtful type who are about to enter the Navy or are already in it. (615 pages, 5½ by 8½ inches, one map.)—$3.10 postpaid.—*A.G.I.*

SIMPLIFIED PHYSICS

By Small and Clarke

Physics isn't simple and can't be made so, but this is a good effort in that direction. It will be a help to those who struggle alone with the more formal treatment of the conventional textbook. It covers the older physics—not, however, trying to scale the heights of atomic physics. There are short, modern chapters on the dial telephone, airplane, radio altimeter, radio compass, television, electron microscope, sound ranging, and color photography. (427 pages, 5 by 7¼ inches, 163 illustrations —$3.10 postpaid.—*J.P.C.*

NORTON'S STAR ATLAS AND TELESCOPE HANDBOOK

By Norton and Inglis

New edition (ninth) of a standard star atlas whose eighth edition was reviewed here November, 1942. Chief changes: Main charts redrawn for epoch of 1950; some stars added, others omitted; N.G.C. numbers now on most nebulae; 6th or 7th mag. variables encircled; new I.A.U. galactic poles adopted. This atlas is still the main standby for amateurs past the cradle roll. (90 pages, 8½ by 11 inches, 2(maps.)—$5.00 postpaid.—*A.G.I.*

SCIENCE FROM SHIPBOARD

By A Group of Scientific Writers

Service men going overseas crav answers to 1000 questions abo things en route. This pocket sized bo by well-known scientists, with chapt on: Waves, wind, and weather; su moon, and planets; time, calendar, a sundial; stars; navigation; ocean geology; sea life; oceanic birds; ships; a seasickness, gives these answers. (2 pages, 4½ by 7 inches, 138 illustratior cloth bound.)—$1.60 postpaid.—*A.C*

Telescoptics

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

How many finished mechanics are there in this nation of Yankees, besides those who make their living at it? Maybe the makers of lathes and machine tools know. Who trains them? Many train themselves, or are apparently born trained.

Figure 1 shows one of this legion, Henry Paul, 119 North Broad St., Norwich, N. Y., with a home-made tripod and mainly machined mounting carrying a purchased telescope and camera. Figure 2 shows interesting details of the mounting. Paul is a chemical engineer, with a doctorate in nutrition from Cornell, and is director of a vitamin laboratory for a pharmical house. Shop work represents his relaxation, or escape. His cellar shop is well equipped, though not over-equipped, with machine tools. There are thousands more of the same type of amateur mechanic in Yankeedom—more or less born tool-minded.

The telescope is an old 3½" refractor by the forever famous Alvan Clarke. Paul states: "I have never seen a better objective. It is perfect. It gives perfect diffraction pattern and spurious disks." Paul has also made objective lenses.

The stubby camera is a Zeiss and has a 2½" aperture Sonnar lens of 7" f.l. It covers a 14° field and cost $450, which is a lot of simoleons for an amateur astronomer.

The tripod weighs 35 pounds and is solid brass. It just fits a car crosswise, and, at home, a 4" pipe in a ton of concrete on bed rock.

Commenting on the mounting Paul writes: "It has a ball-bearing polar axis and main worm with friction slip-ring to hour circle. The second worm is jeweled. Reduction is 235:1, plus 22·1, to a regular 2-watt, 3.6 rpm Telechron house clock motor as sold by the thousands. This gives one revolution in 1436.11 minutes, which is plenty close to the sidereal day. If others wish to use this small motor, they should use a ball-bearing polar axis, install a 15,000-ohm, 1-watt radio resistor in its housing to keep the motor warm, and mount it not closer than 1" from any large iron or steel object, as this upsets the synchronization.

"The trailer hitch, ball-and-socket mounting for the camera is handy. I have found Eastman Spectrographic Plates No. 103aE, extremely fast, particularly for dim objects of broad expanse, and very red-sensitive," Paul

Figure 1: Paul and two fortunes

continues. "Used with a gelatin No. 12 (minus blue) filter, moonlight fog and sky fog can almost be eliminated with only a 50 percent increase in exposure. For direct exposure on the Moon at focus I use 35mm Eastman miniature microfilm (good for 20X enlargement) and develop twice normal in D-76. This gives correct contrast. Exposure varies from 1/10 to 1/50 second at $f/8$, depending on phase of Moon. Eastman microfilm has a resolving power of 135 lines per mm, against about 50 for most films, and the high contrast is perfect for lunar work. In a pinch, regular high-speed press plates could be substituted for the spectographic plates."

Paul sends no data on Figure 2. The photographs practically explain themselves and the detail is well worth close study.

Paul submitted some beautiful stellar photographs enlarged to 6" diameter from the 1" diameter originals, but no attempt is made to reproduce them here, for the same reason that has excluded many others kindly sent to this department: The half-tone process degrades them all to the same low level—the good ones, the indifferent ones, and the bad ones alike. The chances are, however, that a capable wangler could wangle photoprints from Paul, if he could exchange some similar work of his own for them.

This worker was a member of Scientific American's famous Amateur Roof Prism Gang. Too busy with his regular vocation to go into actual production, he nevertheless proved up his ability to make a high-grade roof prism, and then made a limited number in order to be sure he could do it every time. These tested up very well by others. To ex roof-prism makers the easier mirror work is going to seem like duck soup after the war. They'll be a kind of royalty of the hobby fraternity.

Ecclesiasticus is one of the apocrypha and in the first verse of the thirteenth chapter it says: "He that toucheth pitch shall be defiled." (See "A.T.M.," page 359). Quite obviously, the author or authors of Ecclesiasticus must have been trying to make a telescope.

Here is a contribution by Dr. D. Everett Taylor, 191 Prospect St., Willimantic, Conn., who has touched pitch and been duly defiled, as have we all in our time.

"Channeling a pitch lap is one of the headaches of telescoptics. Cutting shallow channels in a revolving lap, using the point of a pen-knife, is simple. Reasonably simple also is molding the channels in a large lap with the aid of a rubber mat. On the other hand, rolling or melting in the channels on a pitch lap already formed to curve distorts the pitch surface. Cutting pitch with a knife or razor blade is tedious.

"The drill press furnishes a quick and highly satisfactory means of producing almost any desired type and size of channel. Point an old or broken twist drill with two pairs of surfaces at about 45° from the drill's axis, or point a large spike or rod with a similar, square, regular pyramid (spikes come

Figure 2: Details of mounting. For rough, temporary end-nut in first photograph substitute streamlined version in second

already pointed that general shape but the angles are too steep). Run the tool thus made at 600 to 900 rpm.

"Draw the lap, freehand, across the rotating tool thus made, until the desired width and depth are attained. An alternative, not quite so good, is a succession of slightly overlapping holes made with the same tool.

"The quarter-inch tool will thus produce a wide variety of channels, both in depth and width. For wider ones, increase its diameter."

LUNARIANS will find much of permanent value in a 76-page booklet reprint of articles by Walter H. Haas, entitled "Does Anything Ever Happen on the Moon," originally published serially in *The Journal of the Royal Astronomical Society of Canada*. It contains a list of lunar observers, data on observational procedure, drawings, discussion of each, on lunar colors, on lunar changes (the essential subject of the writings), and on the lunar atmosphere, also an extensive bibliography. David P. Barcroft, First National Bank Building, Madera, Calif., a member of the wide-spread observing group whose work is discussed, has a number of copies but only a limited number, which he therefore will be forced to allot for sale only to those who can show genuine interest. Barcroft also is a member of the Telescope Makers of Central California, of which Harry R. Lytle, of Madera, is now secretary.

TEMPLATES for gaging the depth of concavity of a telescope mirror are described in "Amateur Telescope Making" by Porter on page 3, and by others on pages 310 and 344. While it is thought that a majority use the Ellison method of reflection from a wetted mirror, as described on page 78 of that book, some prefer the template, which is easier and simpler once it is made.

Figure 3 shows how Warner Williams, connected with the Culver Military Academy at Culver, Indiana, made his template. Abrasive paper was glued to the face of a motor-driven wooden disk, and the metal template strip was attached to the radius bar, pivoted at the left, far out of the picture. This bar then was worked back and forth as the motor ran.

There came, one day, to your scribe's office a large express package containing, when opened, the striking bas-relief, or plaque, made by Williams and shown in Figure. 4. This measures ¾" x 12½" x 16" and is made of cast plaster painted a delicate shade of green. William's letterhead indicates that he is a Chicago sculptor and de-

Figure 3: Williams' template job

Figure 4: Foucault by Williams

signer. He made the bas-relief from the picture of Foucault on page 511 of "A.T.M.A."

This copy, cast from a negative which he has, now hangs on your scribe's office wall beside the famous framed original focogram of Mary Everest's mirror (reproduced in "Amateur Telescope Making—Advanced," page 24). Williams has also donated duplicate copies of the plaque to Russell W. Porter and to Stellafane. He states in his letter what probably few amateur telescope makers know, that Cassegrain was a sculptor.

BROKEN tool needn't mean a broken heart. Cyril G. Wates, Edmonton, Alberta, writes: "We are told in 'A.T.M.' what to do in case of a broken mirror, but not in the case of a broken tool. The latter is much more common because it is standard practice to immerse the tool in warm water to soften the pitch, and because tools are generally plate glass which has a high coefficient of expansion, and are therefore more likely to crack than Pyrex blanks.

"My friend, H. W. Parnall, of Foothills, Alberta, recently had the misfortune to fall down the cellar stairs while carrying a 10" plate-glass tool. (Parenthetically, Mr. Parnall has a pet dog which weighs more than he does. When Fido gets hungry, his master goes out and shoots a moose. After satisfying doggie's appetite, Parnall sends me what's left of the moose. In return, I give him bad advice on the subject of telescope making.)

"To return to our muttons, Parnall wrote and told me about his accident, adding that he had mended the broken tool and finished the mirror on it. In reply to a slightly sceptical question, he said laconically: 'I wound stovepipe wire around it.'

"Now it happened that I too had cracked a plate glass tool, via the hot-water route. Taking a leaf from Parnall's book, I made a band of steel out of an old clock spring, with a screw for tightening. Having carefully cleaned the broken surfaces of the glass, I coated them with china cement, brought them into contact, put the steel band in place, tightened it, and have been using the tool ever since."

INDEX TO VOLUME 169, JULY—DECEMBER, 1943

Printed in the U. S. A. Press of [illegible] Wil[illegible] [illegible]mpany, Orange, Connecticut.

The Rubber Plant

with roots two miles deep!

THE MAKING OF synthetic rubber involves among other things the exact control of gas mixtures of great complexity. Formerly the analysis of some gases required several days of painstaking laboratory work, and in some cases a complete analysis was impossible.

Westinghouse scientists—working in close collaboration with engineers of leading oil and chemical companies—have perfected an electronic "chemist" which is an important addition to the present methods of analysis.

With the improved technique and apparatus now available, the time required for accurately making some of these analyses has been reduced *to an hour or less!*

An amazing electronic device . . . known as the* mass spectrometer *. . . not only improves the accuracy of the synthetic rubber process, but frees hundreds of skilled chemists from tedious but important production testing in these vital plants.

The mass spectrometer analyzes gases by sorting the molecules—according to their mass—in (roughly) the same way that a cream separator sorts out the cream from whole milk.

Let's say we want to analyze a simple gas mixture containing *one part* of oxygen and 10,000 parts of nitrogen. Here's how the mass spectrometer accomplishes this incredible feat:

First, the gas sample is bombarded with electrons. This *ionizes* the nitrogen and oxygen molecules, giving them electrical charges of their own.

These ions are then drawn by electrical force into a curved vacuum tube. Here, ions of different molecular weights whizz around *different curved paths*—depending upon their reaction to a powerful electromagnet surrounding the tube.

The heavier oxygen ions follow a straighter path than the lighter nitrogen ions and are directed through a tiny exit slit onto a plate where they give up their electrical charge. The amount of this charge, amplified and recorded by sensitive electrical instruments, is an extremely accurate measure of the *quantity of oxygen* in the gas mixture.

The starting voltage is then changed to allow the nitrogen ions to pass through the same exit slit—thus measuring the *quantity of nitrogen*. This same principle applies to the analysis of complex hydrocarbon mixtures.

The development of the mass spectrometer . . . for the quick, accurate analysis of butadiene . . . is a typical example of the way Westinghouse "know how" in electronics is tackling the wartime problems of industry in an effort to speed victory.

Westinghouse Electric & Manufacturing Company, Pittsburgh, Pennsylvania.

Westinghouse

PLANTS IN 25 CITIES — OFFICES EVERYWHERE

Exploring a New Universe

THROUGH those small round windows—observation ports of an RCA Electron Microscope—this bacteriologist is studying influenza virus—magnified 25,000 times!

For years medical research men have had to fight the devastation of influenza "blindfolded" — for the simple reason that flu germs are invisible even under the most powerful light microscope. *But why invisible?* Why couldn't this virus be seen? The answer is—even the shortest waves of visible light are *far too long* to permit seeing anything so small. Nothing so infinitesimal ever was seen—or could be seen—prior to invention of the Electron Microscope.

But man *needs* to see these smaller things—among which are long-hidden causes of many diseases destructive to human beings animals and plants. Man *needs* to be able to peer down, down, down into molecular structures—in order to learn what makes rubber behave like rubber, leather like leather, wool like wool, lubricating oil like lubricating oil, or metal like metal. For under the whiplash of war it is imperative to learn now, not tomorrow, *why* one kind of rubber, leather, fiber, oil or metal is more elastic, tougher, stronger, more useful than another.

Every branch of science and industry can benefit through proper use of this extraordinary microscope—which utilizes electrons instead of light for illumination. The RCA Electron Microscope is only one of many RCA applications of *electronics*—the art of harnessing electrons to the service of man. Every electronic device of *every* kind depends basically on electron tubes. And RCA is the fountain-head of modern electron tube development.

In addition to our armed forces, the list of industrial firms and scientific institutions now using RCA Electron Microscopes reads like a Blue Book of American Industry and Science. Inquiries regarding this instrument will be welcomed from research men connected with similar organizations, and will be promptly answered. Address Department 131-765, RCA Victor Division, Radio Corporation of America, Camden, N. J.

TUNE IN "WHAT'S NEW?"

RCA's great new show, Saturday nights, 7 to 8, E. W. T., Blue Network.

A new booklet—"RCA ELECTRONICS IN INDUSTRY"—may suggest electronic applications important to your business. Free on request. Please use business letterhead when writing. Address—Dept. 68-2N RCA Victor Division, Radio Corporation of America, Camden, New Jersey.

BUY WAR BONDS

RADIO CORPORATION OF AMERICA